
Ex-libris
Charles Atwood
Kofoid
BMC

C A Kofoid

MICROSCOPIC OBJECTS

FIGURED AND DESCRIBED.

BY

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HONORARY SECRETARY TO THE MAIDSTONE AND MID-KENT
NATURAL-HISTORY SOCIETY.

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MDCCCLXX.

ALERE FLAMMAM.

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TO

MY VALUED FRIEND

DR. BOWERBANK, F.R.S., F.L.S., F.R.M.S., &c.,

I DEDICATE THIS WORK.

J. H. MARTIN.

PREFACE.

Microscopy has of late years taken such a hold on cultivated minds, that I believe an apology for sending this work into the world is scarcely needed.

It commences with some of the primary forms of Vegetable life, and proceeds onwards through the tissues to the woody structures of the Exogens and Endogens, next descending to the Acrogens, and so passing to the extreme limits of vegetable life, as the Desmidieæ &c.,—thence to the lower forms of Animal life, the Infusoria, and on through the Radiata to the Insects, which are drawn and described in their various orders, and the minute organs figured separately.

In the concluding Plates are represented interesting and characteristic geological structures, with some of the more curious forms and groupings of crystals.

It has been my aim to represent as faithfully as possible some of the forms of hidden nature; and I sincerely trust

that they will be found useful both to the student and to the lovers of natural beauty. My thanks are due to Drs. Griffith, Smyth, Plomley, and other gentlemen for their kindness during the progress of the work.

JOHN H. MARTIN.

Week Street, Maidstone,
December 1870.

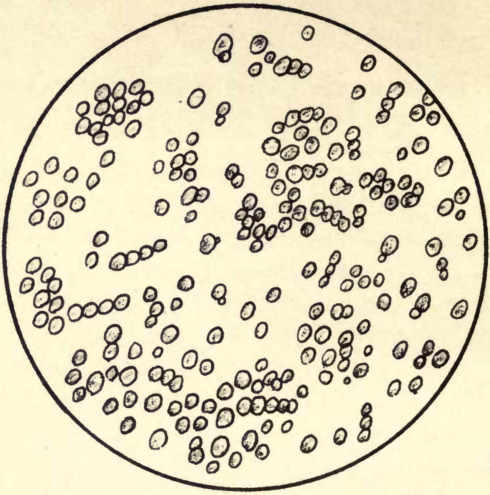

Fig. 1.

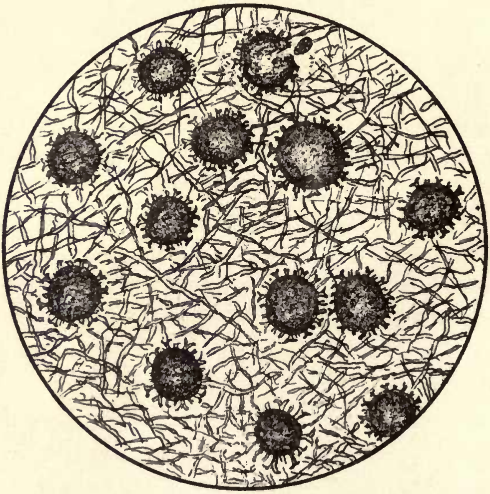

Fig. 2.

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Fig. 1.—*The Yeast-plant* (Torula cerevisiæ *or* T. sacchari), × 240 diameters.

This drawing of the Yeast-plant may be taken to represent the typical form of a single cell. The cells increase by the process of budding. In some parts of the figure the cells may be seen in the act of throwing out a bud; while in others they are united into a perfect chain, which corresponds to a more advanced stage of growth. The manner in which this plant causes the conversion of sugar into alcohol is at present imperfectly understood; but, from some cause, during the growth of the plant, carbonic acid is thrown off, while alcohol remains in the liquid.

This plant belongs to the Coniomycetous order of Fungi.

The cells vary from $\frac{1}{2000}$ to $\frac{1}{4000}$ inch in diameter. They are best examined when mounted in liquid.

Fig. 2.—*Maple-blight* (Uncinula bicornis), × 90.

This figure represents the well-known blight or mildew which is found on the leaves of the Maple, chiefly in the months of September, October, and the early part of November; the hedges in the country may sometimes be seen quite white with this blight. The fine fibres in the drawing illustrate the web of the mildew, and the globular bodies the conceptacles, or cases, in which the eight sporangia are stored for future use; each sporangium contains eight spores. This blight belongs to the Ascomycetous order of Fungi.

The diameter of the conceptacles is from $\frac{1}{30}$ to $\frac{1}{80}$ inch.

This object may be mounted either in the dry state, in balsam, or in liquid.

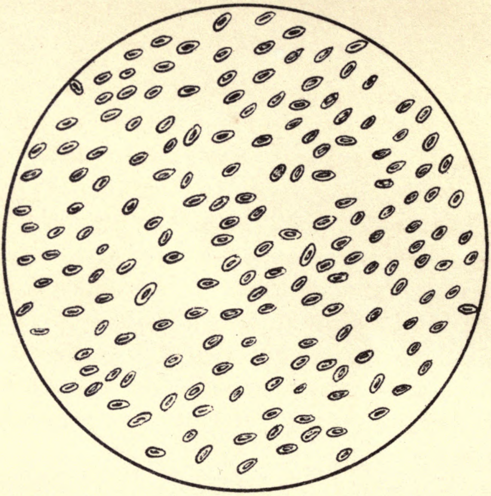

Fig. 3.

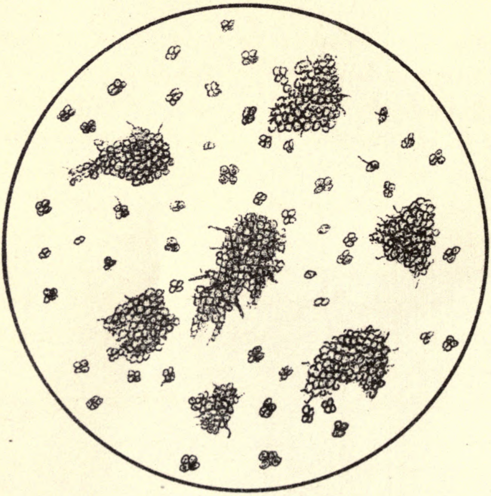

Fig. 4.

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Fig. 3.—*Spores of the Mushroom* (Agaricus campestris), $\times 200$.

This drawing illustrates the spores, as they are called, of the common Mushroom, drawn immediately after they were shed by the mature plant. Spores agree so far with seeds, that they reproduce the plant. In their natural growth on the gills they are called basidiospores; these are common to both the Hymenomycetous and Gasteromycetous Fungi. In the Hymenomycetous, of which the Mushroom is an example, they are produced on the surface of the gills (hymenium), and generally at the four extremities of a branched cell. The spores are at first nearly colourless, but afterwards gradually acquire a brownish tint. In some species of Fungi they remain white.

The spores are from $\frac{1}{3000}$ to $\frac{1}{4000}$ inch in length, and from $\frac{1}{4000}$ to $\frac{1}{4800}$ in breadth. They are best viewed when mounted in liquid.

Fig. 4.—*Frond of a Confervoid Alga* (Chlorococcum vulgare), $\times 200$.

This drawing illustrates the green dust or powdery layer (*Chlorococcum vulgare*) so commonly found on old palings, trunks of trees, &c. The minute seed-like bodies, mostly arranged in groups of fours, of which this substance consists, keep on increasing by cell-division; at least, according to our present knowledge, they have not been proved to arrive at a higher state of being—in this respect differing from the spores or seed-like bodies of the Mushroom. It is thought by some scientific observers that it is only a lower form of some lichen; but the present state of knowledge upon this point is rather uncertain.

The diameter of the groups of spore-like bodies is from $\frac{1}{2000}$ to $\frac{1}{1000}$ inch.

They may be mounted either in the dry state, in balsam, or in liquid.

Fig. 3.—*Spores of the Mushroom* (*Agaricus campestris*), ×300.

This drawing illustrates the spores, as they are called, of the common Mushroom, drawn immediately after they were shed by the mature plant. Spores agree so far with seeds, that they reproduce the plant. In their natural growth on the gills they are called basidiospores; these are common to both the Hymenomycetous and Gasteromycetous Fungi. In the Hymenomycetous, of which the Mushroom is an example, they are produced on the surface of the gills (hymenium), and generally at the four extremities of a truncated cell. The spores are at first nearly colourless, but afterwards gradually acquire a brownish tint. In some species of Fungi they remain white.

The spores are from [illegible] to [illegible] inch in length, and from [illegible] to [illegible] in breadth. They are best viewed when mounted in liquid.

Fig. 4.—*Frond of a Confervoid Alga* (*Chlorococcum vulgare*), ×300.

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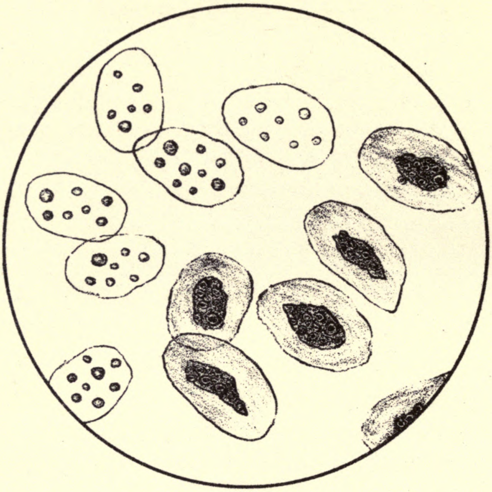

Fig. 5.

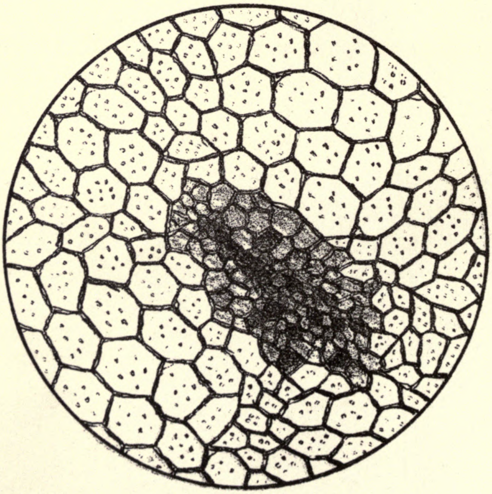

Fig. 6

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Fig. 5.—*Cells from the Apple* (Pyrus malus), × 100.

It will be noticed that some of these cells are darker than the others; these have been treated with sulphuric acid and iodine, which causes the cell-contents or protoplasm to contract towards the centre of the cell. Within each cell will be found one or more nuclei, and within these the nucleoli; it is supposed by some that these are the life-centres of the cell.

Sulphuric acid and iodine colour the cellulose of the cell-walls blue, and at the same time render the nitrogenous protoplasm yellowish brown. Cells are often found with thickened walls (see fig. 18), and also with pits or dots, from the irregular formation of the cellulose (see figs. 8, 10, 14, &c.).

The cells are from $\frac{1}{200}$ to $\frac{1}{150}$ inch in length, and from $\frac{1}{400}$ to $\frac{1}{250}$ inch in breadth.

They are best mounted in liquid.

Fig. 6.—*Transverse Section of the Pine-apple* (*the fruit of* Ananassa sativa), × 240.

This section forms an example of the ordinary loose parenchymatous tissue so commonly met with in various fruits and other cellular growths, such as exists also in most annual plants. It will be found, however, that in the case of fruits the cells are usually large, while in the stems, leaves, &c. of plants the cells are generally small.

It is best preserved either in the dry state or in liquid.

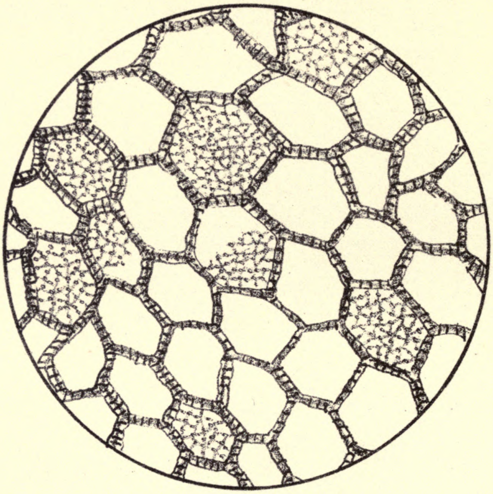

Fig. 7.

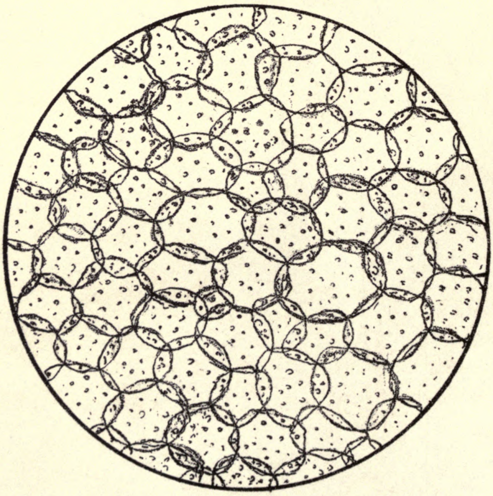

Fig. 8.

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Fig. 7.—*Transverse Section of the Stem of the Water Plantain* (Alisma plantago), × 30, Endogen.

This section of the stem of the Water Plantain has been drawn especially to illustrate the extremely loose form in which the air-passages are often found. They are divided horizontally by membranous partitions, some of which are seen in the figure. These are composed of minute cells, with short processes and intervening air-spaces, somewhat resembling the structure met with in the Rush.

This section is best mounted in liquid.

Fig. 8.—*Transverse Section of Elder-pith* (Sambucus nigra), × 90.

This section shows the pitted membrane which forms the cells. The pitted appearance is caused by an irregular formation of the secondary deposit. Although the pits may seem to be holes in the membrane, on the application of sulphuric acid and iodine they will be found to be coloured, as well as the surrounding tissues, which would not occur if they were holes. Membrane is sometimes thickened by a dense deposit, so as to have nearly the appearance of bone (see fig. 18 &c.).

This pith (Elder) is often used by microscopists to clean their object- and eye-glasses.

It may be mounted dry or in liquid.

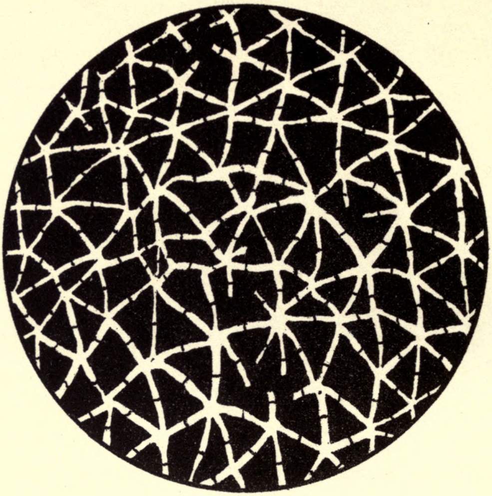

Fig. 9.

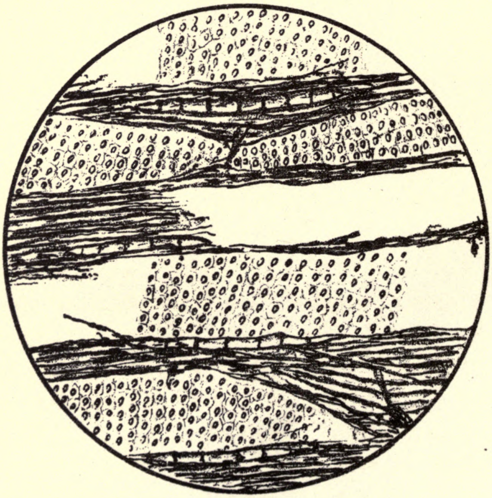

Fig. 10.

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Fig. 9.—*Stellate Tissue from Rush* (Juncus communis), × 90, Endogen.

This drawing is from a transverse section of the pith from the stem of the Rush, as seen under the parabolic reflector. It illustrates the stellate parenchyma, or cellular tissue. The form of the component cells is generally that of a six-rayed star, the ends of the rays of one cell being in apposition with those of the surrounding cells. The intervals between the cells, or the intercellular spaces, as they are called, in this case, as in most water-loving plants, contain air; and it is this, together with the loosely formed stellate tissue, that tends to make the Rush so light and elastic. When the pith is mounted in liquid or in Canada balsam, the air is displaced, and the whole appears transparent.

It is best seen when mounted dry, but may be well viewed in liquid.

Fig. 10.—*Longitudinal Section of the Willow* (Salix alba), *showing dotted ducts* in situ, × 240, Exogen.

This section is the same as fig. 66, only much more magnified; it illustrates the *dotted ducts.* Ducts are regarded as a form of vascular tissue terminating in abrupt or blunt ends, by which characteristic they may be distinguished from *liber-cells* and *vessels,* which terminate in *tapered* ends (see figs. 13, 14, & 17; also Wood Sections); when examined under a high power, say $\frac{1}{8}$, they appear much dotted, whence the name. The tissue of which ducts are composed (unlike true vascular tissue) cannot be unrolled.

It is best examined in the dry state.

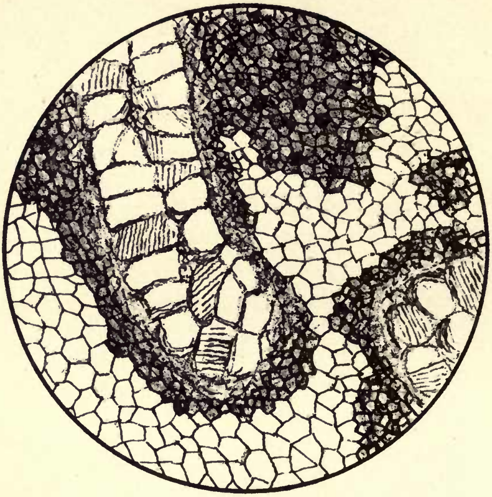

Fig. 11.

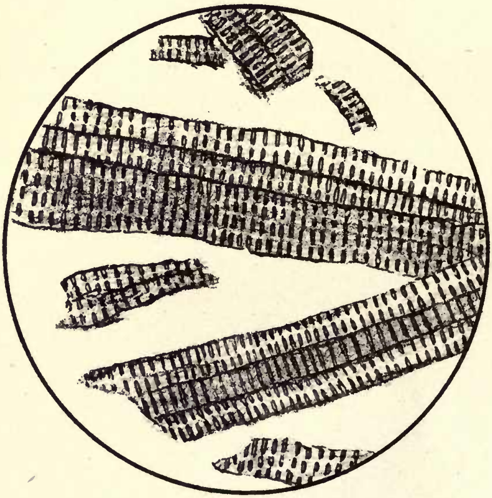

Fig. 12.

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Fig. 11.—*Oblique Section of the Root of the Brake Fern* (Pteris aquilina), × 90, Acrogen.

This section shows the scalariform tissue *in situ*. As will be perceived, it is seated in a mass of cellular tissue, of which the section is chiefly composed. Around the scalariform ducts there is an evident aggregation of smaller cells (see fig. 12 for a further description).

It is best viewed in the dry state or in balsam.

Fig. 12.—*Scalariform Tissue from Brake Fern* (Pteris aquilina), × 220.

Scalariform tissue is found in close bundles; and immediately around these bundles are packed a quantity of wood-cells (see fig. 11). These are again closely packed in parenchyma or cellular tissue. The name of the tissue is derived from the Latin *scala,* a ladder, which the ducts greatly resemble. It is chiefly found in the Ferns; but when met with in the higher plants, it has a tendency to pass into the form of pitted ducts. Scalariform tissue may sometimes be slightly unrolled.

It shows best when mounted in liquid.

Fig. 13.

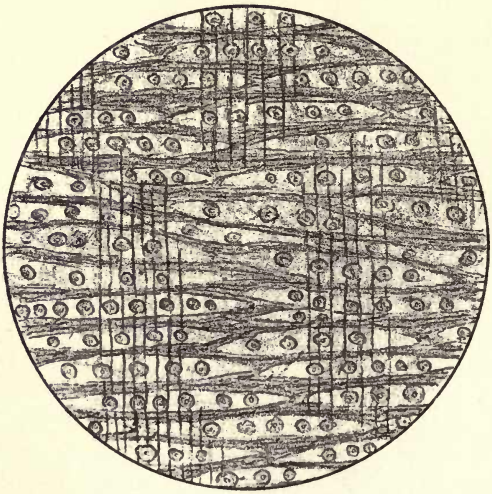

Fig. 14

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Fig. 13.—*Longitudinal Section of the Wood of the Elder* (Sambucus nigra), × 120, Exogen.

This figure illustrates the longitudinal sections of the medullary rays, as seen *in situ.* They appear as dark, oblong, and pointed groups of cells in the mass of the ligneous or woody tissue. It is these cells which give the rayed appearance to transverse sections of the Dicotyledonous woods (see Transverse and Longitudinal Sections of the various woods, figs. 68, 69, &c.). The rays cross the annual *circles* existing in the wood, and which indicate the age of the Dicotyledonous trees. These cells generally become closer as they advance in age.

The object is best viewed in the dry state.

Fig. 14.—*Longitudinal Section of American Pine* (Pinus Strobus), × 120, N. O. Coniferæ.

This section is used to illustrate the so-called glandular tissue, which really consists, however, of pitted cells or vessels. The cells are very numerous in this wood; and the pits will be seen in each cell with a bordered outline, or, as it is in reality, a slight concavity in the surrounding substance. There are pitted ducts, as well as vessels, in other vegetable structures (see fig. 8).

The cross lines in this figure represent portions of medullary rays.

The pits or dots on this tissue are often used to test the quality of the object-glass of the microscope. When this is good, they will appear free from colour.

They are best seen in the dry state.

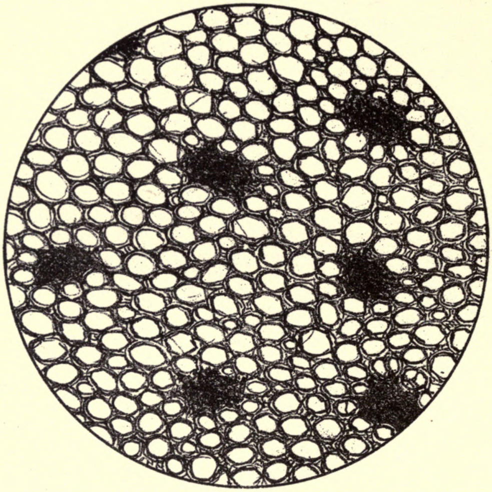

Fig. 15.

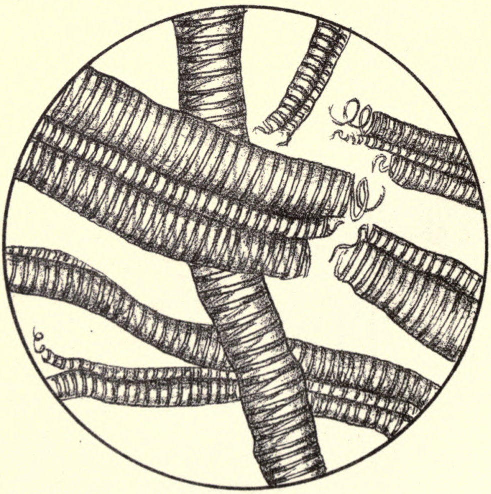

Fig. 16.

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Fig. 15.—*Transverse Section of the Stem of the Garden Rhubarb* (Rheum undulatum), × 30.

This transverse section of the Rhubarb is drawn to show the natural position of the vascular tissue when seated in a mass of cellular tissue. The dark spots illustrate the fibro-vascular, and the lighter formation (which is composed of cells) the cellular tissue. For a description of the vascular tissue, see fig. 16.

This should be mounted in the dry state.

Fig. 16.—*Spiral-vascular Tissue from Garden Rhubarb* (Rheum undulatum), × 120.

Fibro-vascular tissue comprises fibro-vascular bundles, vessels, ducts, &c. The drawing shows the spiral-vascular tissue as seen in bundles when taken from the Rhubarb and other plants. This tissue is most important in the growth of young plants, as it then appears to conduct the juices of the plant. Spiral-vascular tissue is characterized by a spiral formation of the secondary deposit; and forms elongated, acuminated cells or vessels, which generally communicate with each other. The spirals are generally single, but occasionally double &c. (see fig. 17). In some vessels these are replaced by rings, when they are called annular. Spiral tissue was formerly called trachenchymatous, from the supposed resemblance to the air-vessels of insects (see dissections of Insects). Scalariform tissue is a kind of spiral-vascular tissue (see fig. 12).

This object should be mounted in liquid.

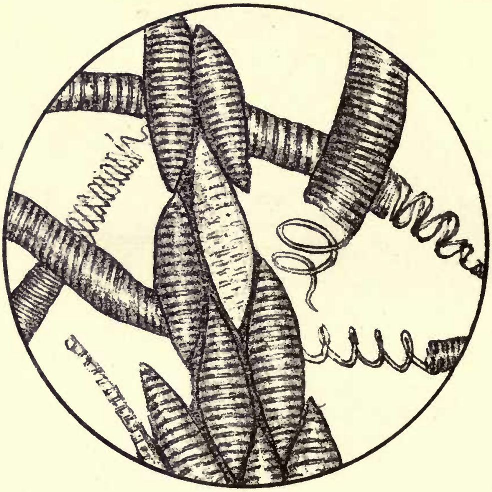

Fig. 17.

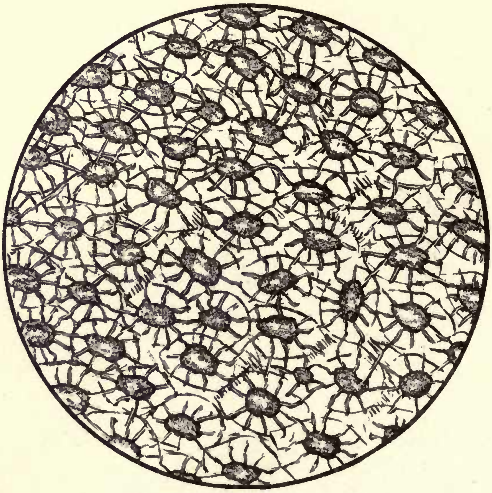

Fig. 18.

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Fig. 17.—*Spiral-fibre Cells from a Cactus,* × 120.

The bundles and vessels of spiral-vascular tissue, in some cases, exhibit the fibre as consisting of two or more spirals, although it is usually single, as in the drawing of the vessels of the Rhubarb (fig. 16). But in the drawing we are now considering, the pointed fibre-cells must be especially noticed. One of them will be seen with the spiral fibre imperfectly formed; from some cause the secondary deposit has not developed a complete spiral, but formed a dotted cell instead. An annular vessel will also be seen on the left-hand side at the bottom of the drawing.

This object may be mounted dry or in liquid.

Fig. 18.—*Section of Vegetable-Ivory Nut* (Phytelephas macrocarpa), × 120.

This section of the Vegetable-Ivory nut is drawn to illustrate the thickening of the secondary deposit alluded to at page 3 (fig. 5). When a section of this nut is made, and ground down until it is very thin, and then mounted dry or in balsam, it will exhibit bodies something of the shape of a compressed cheese-mite (see Mites). This peculiar appearance is caused by the irregular thickening of the cellulose of the cell-wall, called secondary deposit (see also fig. 48).

Cells that are to exist for a long time in any structure always have their cell-wall thickened until it becomes of a bony or horny nature. That this deposit has been gradually formed, may be demonstrated by maceration, or the application of sulphuric acid, which resolves the thickened cell-wall into different layers.

This object is best mounted dry; but it may be mounted in fluid.

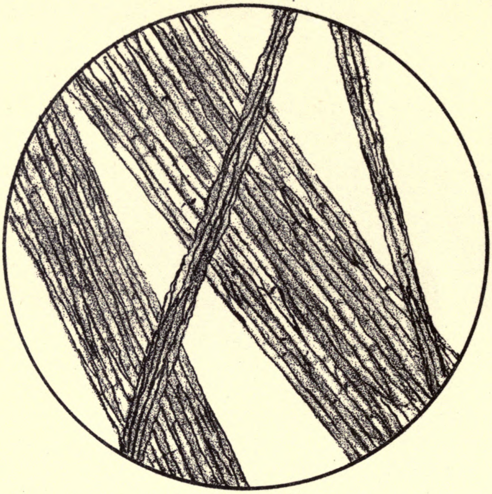

Fig. 19.

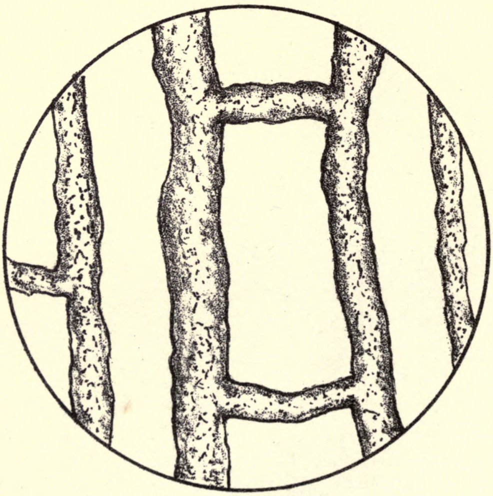

Fig. 20.

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Fig. 19.—*Liber-tissue from Jute* (Corchorus capsularis), × 200.

Liber-cells or -tissue constitute a form of prosenchymatous tissue consisting of elongated cells tapering to a point at each end. These are often united into bundles, as in Hemp, Jute, &c.

When liber-fibres are treated with acids, their individual appearance is considerably altered, although in their ordinary condition they do not appear to differ; but they may always be distinguished from Cotton and other vegetable hairs by their structure.

Most liber-cells appear to have rather a dense thickening of the secondary deposit.

This tissue is best mounted in liquid; but if required for the polariscope, in Canada balsam.

Fig. 20.—*Laticiferous Tissue from the Celandine* (Chelidonium majus), × 120.

This tubular kind of structure pervades the tissues of the Papaveraceæ, Euphorbiaceæ, &c., and may generally be distinguished from the surrounding structures by its peculiar branched appearance, although in some cases it is nearly simple and straight. The canals convey a kind of milky juice, called latex, and they are generally regarded by scientific authorities as being in some degree a part of the system of vessels that contribute to the circulation of plants. The canals seem to thicken in their coats by the deposition of the latex. The common Celandine is one of the most handy plants in which to observe this tissue.

It is best mounted in weak spirit and water. It may be extracted by maceration in water, and subsequent dissection.

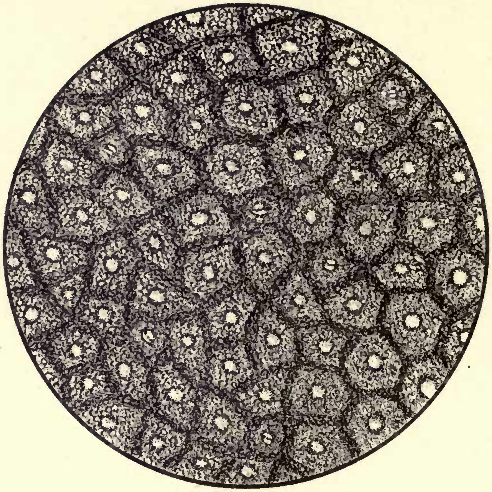

Fig. 21.

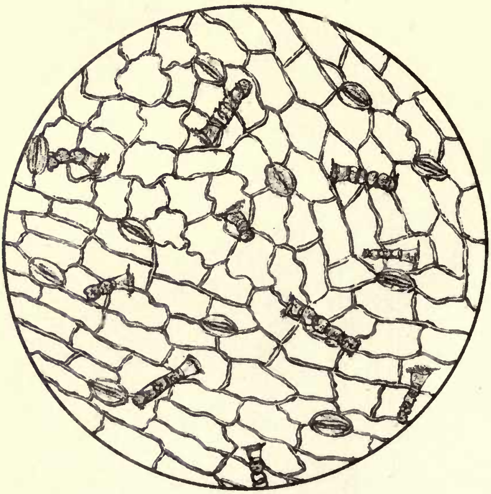

Fig. 22.

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Fig. 21.—*Cuticle of an Orchis* (Oncidium —— ?), × 120.

This cuticle seems to have rather dark stomata, placed in the centre of some of the cells. What appear to be holes, are really papillæ on the surface of the cuticle. In this case the cuticle would no doubt absorb the moisture from the atmosphere much more quickly than in the ordinary form of cuticle, with its larger number of stomata and guard-cells.

The cuticle seems to show best when mounted dry.

Fig. 22.—*Cuticle of Chrysanthemum* (Chrysanthemum Sinense), × 300.

Cuticles of plants, of which this may be taken as a type, form a skin consisting of variously shaped cells with stomata, and in some cases hairs scattered at intervals over the surface. This cuticle was taken from the common garden Chrysanthemum, and has hairs as well as stomata. Stomata have often four guard-cells (see also fig. 24), but sometimes only two (fig. 23). Stomata occur chiefly on the undersides of leaves, except in water-plants, in which they are found on the upper surface of the floating leaves. They are sometimes found on the collum of the apophyses of mosses, as in *Funaria hygrometrica* &c. The use of the stomata is to admit air to the intercellular spaces of leaves &c.; and no doubt they are placed on the under surfaces to prevent their being choked up with dust and other foreign matter.

This object may be mounted in liquid.

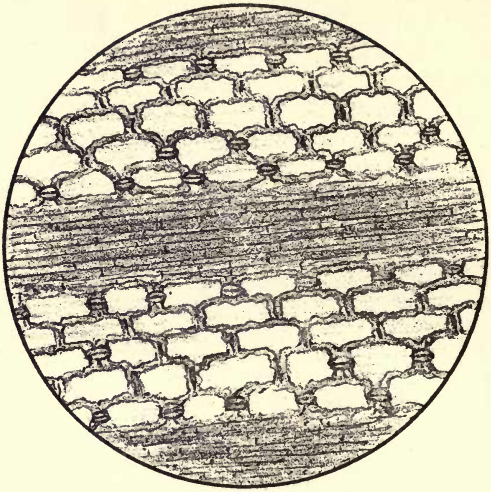

Fig. 23.

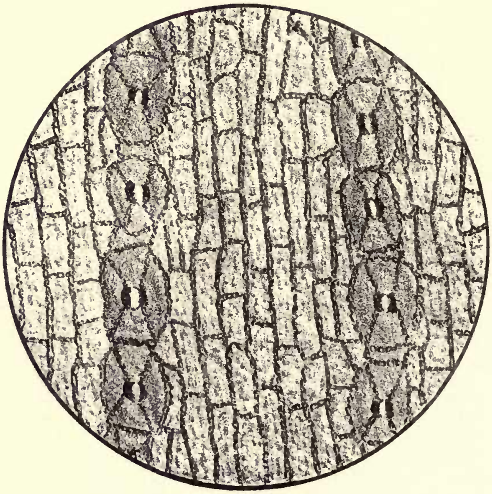

Fig. 24.

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Fig. 23.—*Siliceous Cuticle of Sugar-grass* (Holcus saccharatus), × 120.

Siliceous cuticles are found chiefly in the Glumaceæ and Equisetaceæ. The cells of this cuticle are rather large, and the stomata small—the latter having two guard-cells instead of four, as in figs. 22 and 24.

The cuticle of this grass is easily prepared, the deposit of silex being rather abundant. The best plan is to soak the grass in water for about 24 hours, and then to boil in nitric acid $\frac{3}{4}$, water $\frac{1}{4}$, for a short time, when the siliceous cuticle will separate; or it may be boiled in the pure acid. It may then be mounted in liquid, or dried and mounted in balsam for the polariscope; but glycerine is best.

Fig. 24.—*Cuticle of Araucaria* (Araucaria imbricata), × 120.

This cuticle of the Chilian Pine, on testing with the acids, burning, &c., I find is not siliceous as is generally supposed, but appears to consist of a tough cuticle highly imbued with a resinous substance, so as to be inflammable at a burning temperature. The stomata seem to have four "guard-cells," two lower and two upper. In some leathery cuticles, the cells surrounding the guard-cells appear to be elevated above the surrounding surface.

This object may be prepared by boiling the leaf in nitric acid, and mounting the cuticle so separated in any good liquid. Or it may be dried and mounted in balsam as usual.

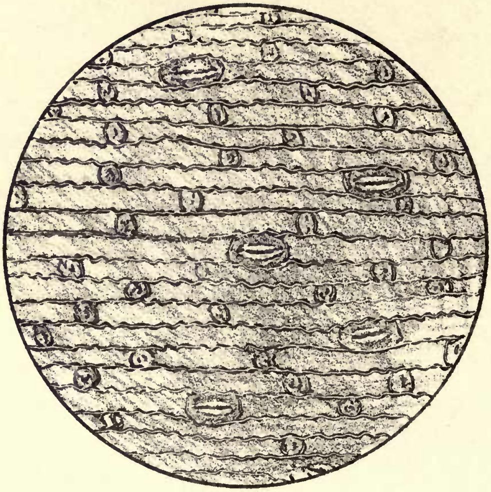

Fig. 25.

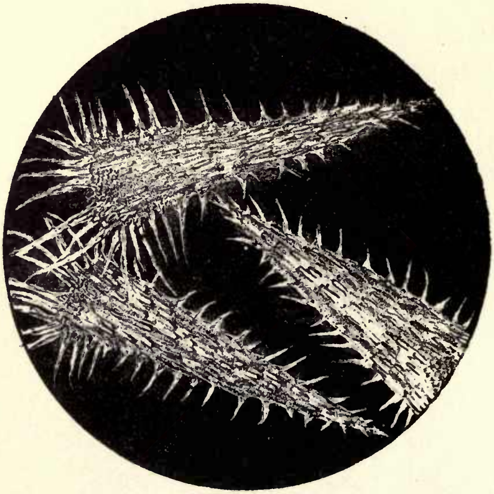

Fig. 26.

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Fig. 25.—*Siliceous Cuticle of Bearded Darnel-grass* (Lolium temulentum), ×240.

This cuticle is taken from the Bearded Darnel, or Rye-grass. When this grass grows in great quantities, as it does occasionally, it is said to be very injurious to grazing cattle. In the Grasses, Equisetaceæ, &c. the cuticle is almost always strengthened by a deposit of pure silex, which may be easily tested by burning a wheat-straw, when the original form remains, which would not be the case if the cuticle had not contained silex. Siliceous cuticles may be prepared by boiling the stems for a long time in nitric acid; but if the object to be prepared is weak in silex, the acid must be diluted with one-third part of water; it may then be well washed in water, and mounted in liquid, or dried and then mounted in balsam in the ordinary manner.

Fig. 26.—*Ramenta, or Scales, from a Fern* (Nothoclæna lævis), ×60.

These scales are drawn as shown under polarized light. On the creeping stems of various species of Ferns, or on the leaf-stalks of scaly kinds, bodies may be found, which are in this case called *ramenta* (Latin *ramentum,* a shaving). In structure these membranous bodies appear to be closely allied to the scales in fig. 27, the chief difference being the point of attachment and the well-marked network of the cells. The common Scale-Fern (*Ceterach officinarum*) owes its remarkable appearance to these ramenta, or scales. The stipes of the male Fern (*Lastrea filix-mas*), and various other British species of Fern, are covered with them.

They may be mounted dry or in liquid; but if required for the polariscope, in Canada balsam, or sometimes in glycerine.

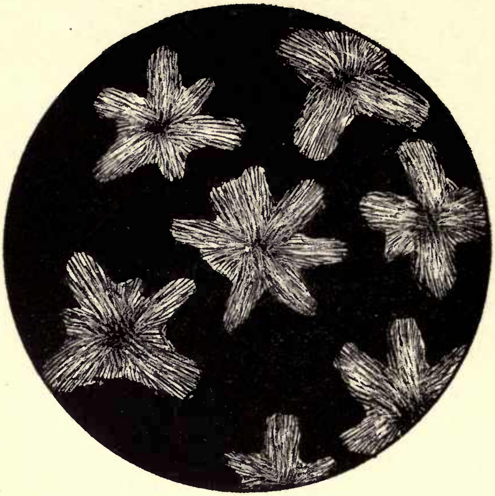

Fig. 27.

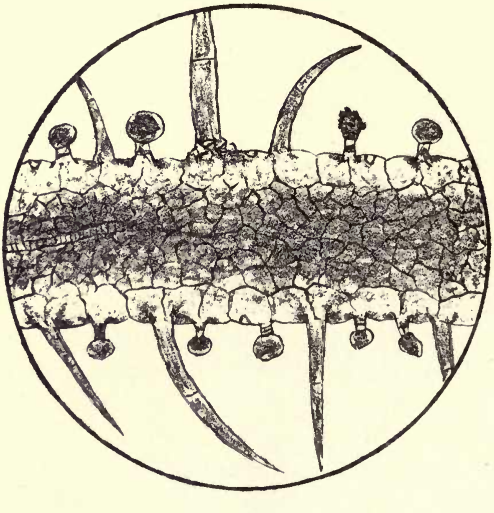

Fig. 28.

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Fig. 27.—*Scales from Elæagnus* (Elæagnus argenteus), $\times$ 50.

Scales of plants, which are chiefly found in those of the natural orders Elæagnaceæ, Bromeliaceæ, &c., some of the Rhododendra &c., are closely related in form to stellate hairs (see fig. 29). Like the hairs, they seem to be attached by the centre to the leaf or stem on which they are growing. By this peculiarity they may be distinguished from the ramenta of Ferns, which are attached by the base (see fig. 26). Most of the scales of plants polarize highly, and they are often of most beautiful stellate &c. forms.

These scales are best mounted in balsam for the polariscope, and in liquid for other examinations.

Fig. 28.—*Section of Leaf of Scented Geranium* (Pelargonium odoratissimum), showing the perfume-glands, hairs, &c., $\times$ 120.

The strongly scented Geraniums are particularly adapted for the observation of the glandular hairs; and in this case most particularly so.

These hairs are of a globular form at their extremities, the globes containing a strong scent, varying in character in the different species of plants from which they are taken. No doubt it has often been perceived that Geranium-leaves &c. yield a strong perfume when crushed; this is caused by the rupture of the globular scent-glands, or hairs. The other hairs seen in the drawing are ordinary compound hairs, composed of two or more cells.

This object is best seen when mounted in liquid.

Fig. 29.

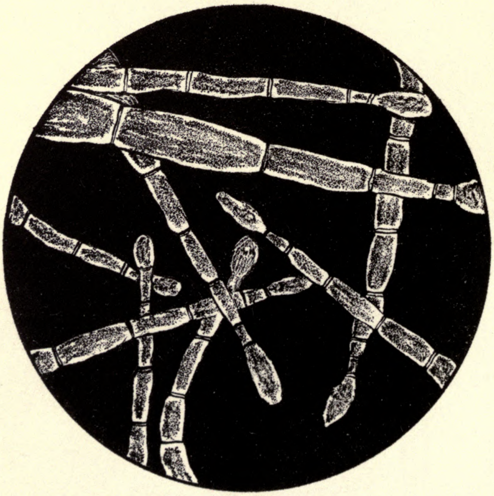

Fig. 30.

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Fig. 29.—*Stellate Hairs from the Ivy* (Hedera Helix), × 90.

These hairs are drawn as shown under the parabolic reflector, and illustrate the stellate form of vegetable hairs. The hairs are taken from the stem of the Ivy, on which they may be seen in great abundance. They appear to consist of groups of simple hairs joined at one end, so as to produce an irregular stellate form. These hairs are compound, being composed of three or more simple hairs, supported on a short footstalk. There are many forms of compound hairs (see figs. 28, 30, 31, &c.). Some hairs, when young and uninjured, are very favourable objects in which to observe the rotation of the protoplasm or cell-contents.

Vegetable hairs are best seen when mounted in liquid.

Fig. 30.—*Hairs from Tobacco-plant* (Nicotiana Tabacum), × 120.

This object is drawn as seen under the parabolic reflector. Tobacco is often largely adulterated with Dock, Cabbage, Coltsfoot, &c., most of which plants have simple forms of hair (see fig. 33), and may thus, under the microscope, be distinguished from the true Tobacco-leaf or stalk, which has compound hairs with a knob at the apex. Most of the hairs are of a rather large size.

The best plan to mount this object is to boil a piece of the stem of the plant in weak nitric acid, say acid 1 part, water 3 parts, when the cuticle will be seen to separate, and may then be mounted in glycerine, or, what is better, alcohol and water.

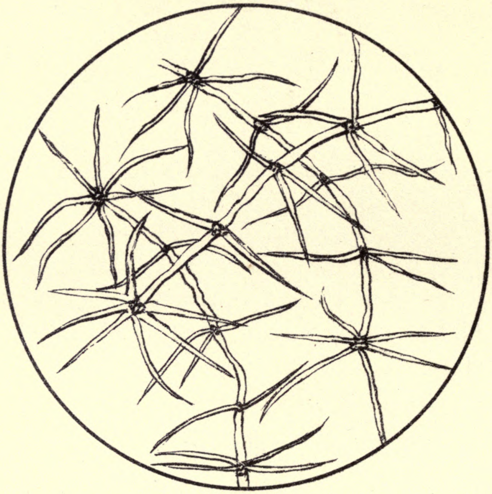

Fig. 31.

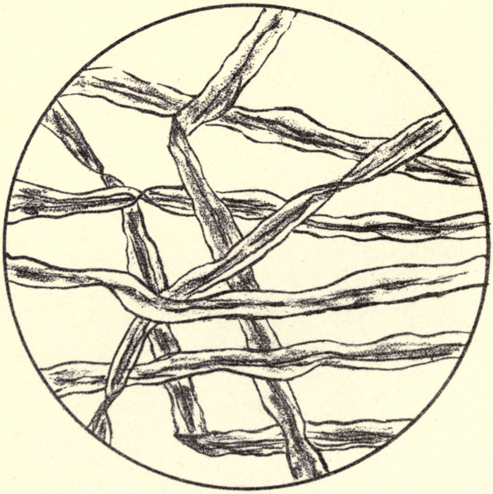

Fig. 32.

Jno. H. Martin, ad nat. del

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Fig. 31.—*Branched Hairs of the Great Mullein* (Verbascum Thapsus), × 60.

It will be perceived from the drawing that this is another example of compound hairs. In this case they take the form of a hair branched at the joints in an irregular manner. The large number of hairs on the Mullein is rather remarkable, its leaves being quite woolly with them. This plant is very common in some counties, more especially where the soil is of a sandy or chalky character.

These hairs are best mounted in liquid.

Fig. 32.—*Cotton-fibre from Seed* (Gossypium herbaceum), × 240.

These hairs, or fibres, have been drawn to illustrate the difference between the various kinds of vegetable textile fabrics, but more especially to show the difference between cotton-fibre and the liber-fibre of jute (see fig. 19)—the cotton hairs appearing like a long flat band, or ribbon, while the liber-cells, or fibres, of the jute are cylindrical and pointed. To distinguish vegetable from animal fabrics, such as wool, they may be boiled in a test-tube with liquor potassæ, when the animal hairs will be dissolved, and the vegetable, such as cotton &c., will remain nearly intact.

This fibre may be mounted dry or in liquid, and in Canada balsam when wanted for the polariscope.

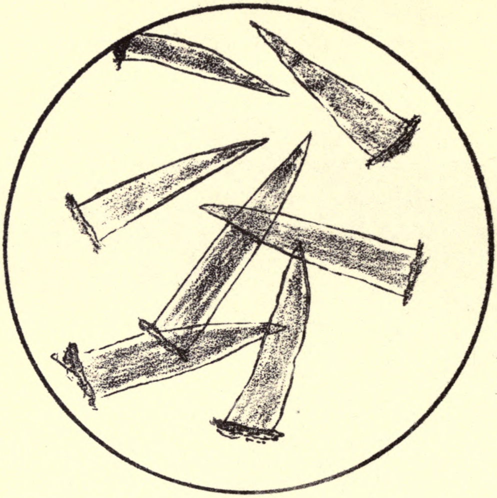

Fig. 33

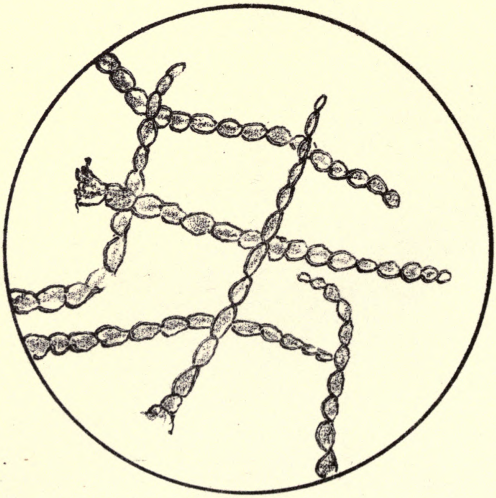

Fig. 34

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Fig. 33.—*Simple Form of Hair from the Cabbage* (Brassica oleracea), × 120.

The simple form of hair is very common on plants, although perhaps not more so than the ordinary straight compound hairs (see fig. 28). The hairs consisting of only one cell makes it an easy matter to distinguish, under a moderately low power of the microscope, say a ½-inch, the compound hairs with their knobbed cells of the true Tobacco, from the adulterations with cabbage-leaves &c., most of which have only simple forms of hairs.

These hairs, together with most vegetable hairs, are best when mounted in liquid.

Fig. 34.—*Compound Beaded Hair from a Stamen of* Tradescantia, × 200.

This compound hair has been drawn to illustrate another form that hairs sometimes take, viz. the beaded form. They are to be found on the common Groundsel, Sow-thistle, and other plants. In fact, on the Sow-thistle they are sometimes so numerous as to give that plant a hoary or frosted appearance.

For other forms of compound hairs, see figs. 28, 29, 30, 31, &c. Hairs of plants are sometimes developed into the form of stings (see fig. 35).

These beaded hairs may be mounted dry or in fluid.

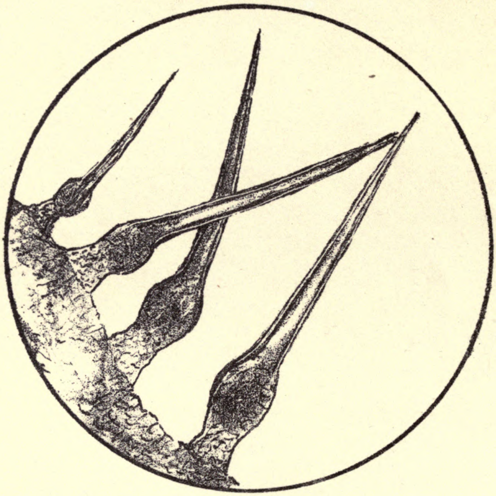

Fig. 35

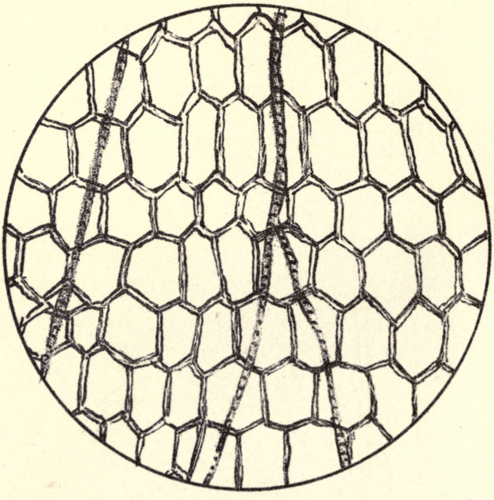

Fig. 36

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Fig. 35.—*Stings from Stinging-nettle* (Urtica dioica), × 40.

Stings of plants may be regarded as enlarged forms of hairs, having a bulbous base, in which the acrid or irritating fluid is contained. They are chiefly found in the N. O. Urticaceæ. The mode of action of the sting is as follows:—Directly the point of the sting is broken off, a fine tube is left exposed; and the sting being at the same time slightly pressed upon its bulbous base, the acrid fluid rises through this tube and enters the flesh at the point made by the puncture of the sting.

These stings may be mounted dry or in liquid.

Fig. 36.—*Petal of Scarlet Pimpernel* (Anagallis arvensis), × 200.

This petal has been drawn to illustrate the spiral-vessels which run up the veins of the petals of many flowers. Another example is shown at fig. 38. Many of the Composite florets show a similar structure well when mounted in fluid or balsam; the florets of *Senecio Jacobæa* form a case in point.

Transverse sections may be taken of some of the thicker petals, as they often show the mamilla in its natural position better than in a semiopaque view.

This petal is best mounted in balsam.

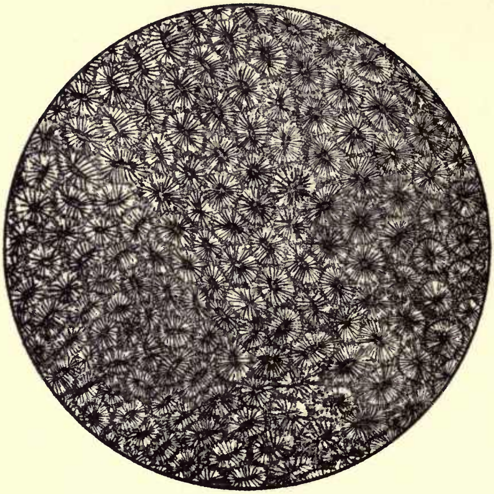

Fig. 37

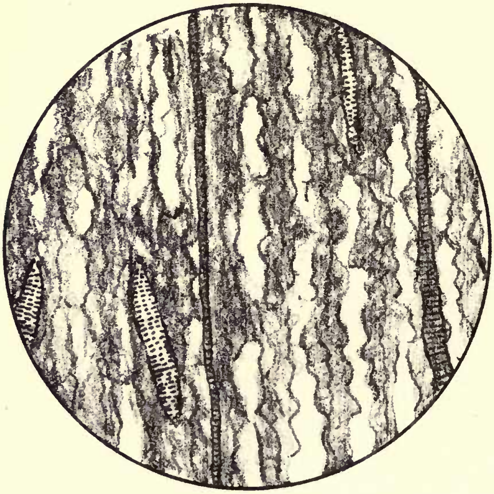

Fig. 38

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Fig. 37.—*Petal of Geranium* (Pelargonium), × 150.

The drawing of this petal is something like fig. 48 in general appearance; but when the two are carefully compared, they will be found to be quite different in structure. For instance, the rayed appearance in the cells of the Geranium is caused by a multitude of minute folds or wrinkles radiating from a common centre in each cell. But it is mainly the central mamillæ that give the fine velvety feel to the petals of many flowers, such as the Geraniums, Pansies, &c.; while the rayed appearance in the cells of the testa of the Vegetable-Ivory nut is caused by the irregular formation of the secondary deposit.

This petal is best mounted dry.

Fig. 38.—*Petal of a Crimson-flowered Cactus* (Epiphyllum), N. O. Cactaceæ, × 350.

The colour-cells of this petal are rather large, and form a wavy kind of structure. The colour of the petal is a deep crimson. The petals seem to contain, amidst their surrounding tissue, a more than ordinarily large number of spiral-vascular cells, which will be seen on referring to the drawing. Many petals contain spiral-vascular cells, which generally run through their entire length (see fig. 36). The best way to mount this petal is simply to soak it in ether for a minute, then to place it in sulphuric acid 1 part, water 2 parts, for a minute or so, until the colour becomes strong, then to wash and dry it, and to mount it in balsam as usual.

Fig. 57.—Petal of Geranium (Pelargonium), ×150.

The drawing of this petal is something like fig. 48 in general appearance; but when the two are carefully compared, they will be found to be quite different in structure. For instance, the rayed appearance in the cells of the Geranium is caused by a multitude of minute folds or wrinkles radiating from a common centre in each cell. But it is mainly the conical nipples that give the fine velvety feel to the petals of many flowers, such as the Geranium, Pansies, &c.; while the rayed appearance in the cells of the testa of the Vegetable-Ivory nut is caused by the irregular formation of the secondary deposit.

This petal is best mounted dry.

Fig. 58.—Petal of a Crimson-flowered Cereus (Epiphyllum). N.O. Cactaceæ, ×200.

The colour-cells of this petal are rather large, and form a wavy kind of structure. The colour of the petal is a deep crimson. The petals seem to contain, amidst their surrounding tissue, a more than ordinarily large number of spiral vascular cells, which will be seen on referring to the drawing. Many petals contain spiral vascular cells, which generally run through their entire length (see fig. 60). The best way to mount this petal is simply to soak it in ether for a minute, then to place it in sulphuric acid 1 part, water 2 parts, for a minute or so, until the colour becomes bright, then to wash and dry it, and to mount it in balsam as usual.

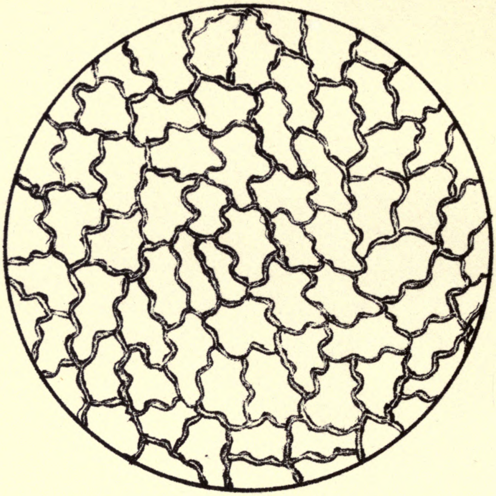

Fig. 39

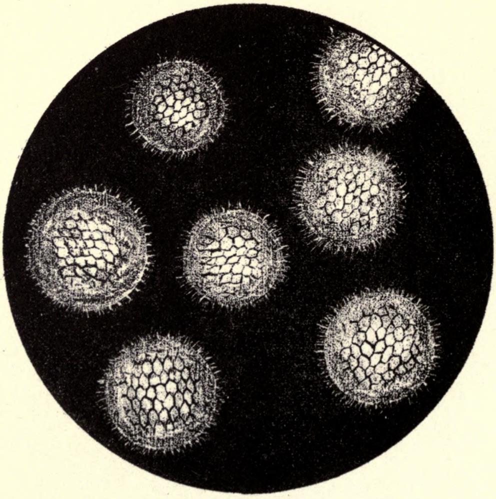

Fig. 40

Jno. H. Martin, ad. nat. del.

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Fig. 39.—*Petal of Fritillary* (Fritillaria meleagris), × 120.

The petal of this flower is rather remarkable for the irregular formation of the cells of the cuticle, which will be remarked on looking at the drawing. The flower is named from the Latin *fritillus,* a dice-box, the coloured markings on the petals slightly resembling the board upon which dice are thrown.

The petal, or rather the cuticle of the petal, of this flower shows best when mounted dry.

Fig. 40.—*Pollen of Convolvulus* (Convolvulus sepium), × 200.

The drawing illustrates the spherical form of pollen, mentioned at p. 21 (fig. 42). Many of the spherical pollens have spiny processes proceeding from the outer cuticle—as the pollen of the Mallow, the Hollyhock, &c. A great many are also furnished with ridges, as in the above drawing. Other examples may be found in the pollens of the Dandelion, *Cobæa scandens,* &c.

Before mounting pollens in fluids, they should be placed in a solution of gum or sugar, as this tends to mitigate the endosmotic action.

In the case of this pollen, it is best when mounted in a dry opaque cell.

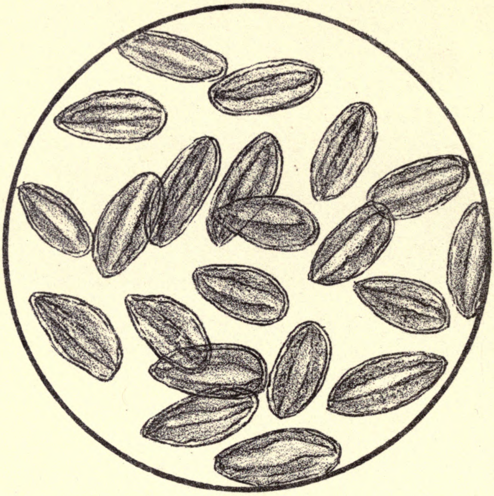

Fig. 41.

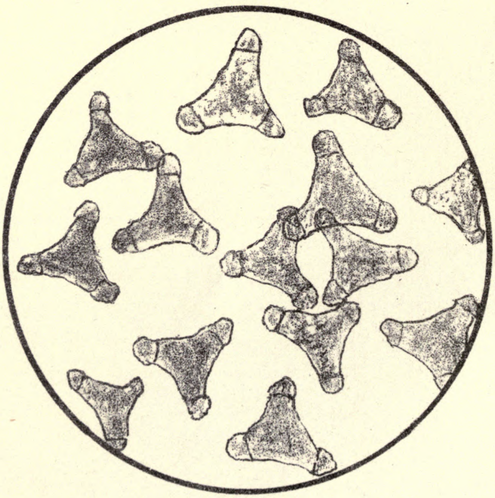

Fig. 42.

Jno. H. Martin, ad. nat. del. Dickinson, Im.

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Fig. 41.—*Pollen of Hyacinth* (Hyacinthus orientalis), × 350.

This drawing illustrates the elliptical form of pollen, mentioned below (fig. 42). The granular protoplasm, which, in the case of pollens, is called the fovilla, appears to be of a less dense character than in most of the elliptical pollens, and is therefore not so much affected by endosmosis on the application of fluids. The skin or cuticle also appears to be tolerably thick. It will therefore be advisable to mount this pollen in fluid. The colour of the pollen is yellow.

Fig. 42.—*Pollen of the Evening Primrose* (Œnothera biennis), × 120.

This form of pollen is rather uncommon, the general forms being chiefly spherical, elliptical, &c. In some plants, as in the Orchids, the pollen coheres in waxy masses. The remarkable characters and forms of the ridges, furrows, &c. which appear on most pollens, seem to be caused chiefly by the contractions of the outer skin or cuticle; these contractions may often be noticed to have disappeared on the application of liquids, such as water &c. Hence it is advisable to mount pollens, when sufficiently transparent, dry, as the best way to retain their natural forms.

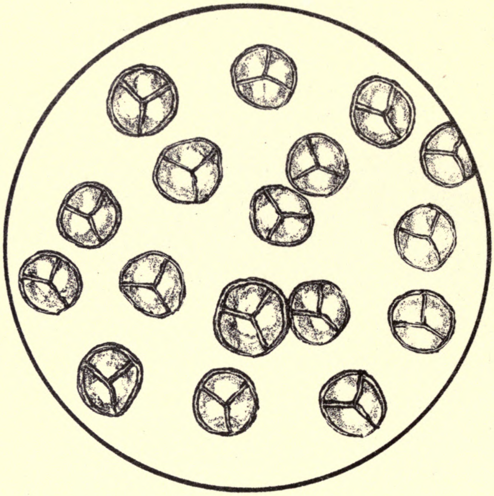

Fig. 43.

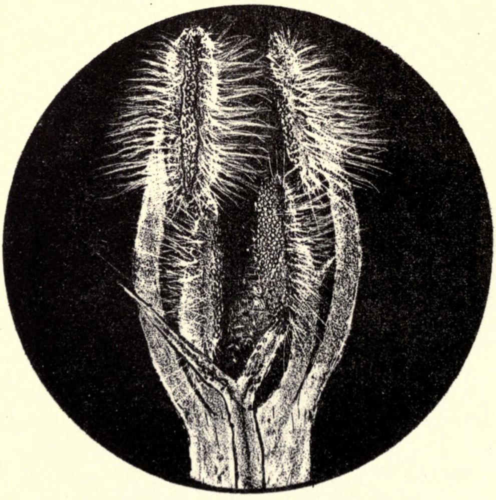

Fig. 44.

Jno. H. Martin, ad. nat. del.

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Fig. 43.—*Pollen from Flower of Strawberry-tree* (Arbutus unedo), × 200.

Many pollens have a remarkably fine and beautiful appearance when viewed under the high powers of the microscope; by their structure, many Natural Orders of plants, and also the different genera, may be distinguished from each other; but I doubt whether the species of one genus can always be distinguished from those of another. Pollens have been comparatively little studied, and in this field alone much work may yet be done.

This pollen, being rather opaque, shows best when mounted in the essential oil of lemon, or any other essential oil.

Fig. 44.—*Stamens and Pistil of Dead Nettle* (Lamium album), × 20.

Stamens, as it is well known, deposit the pollen from their anthers upon the stigma of the pistil of flowers, which is depicted in this drawing. The pollen then throws out a tube, which enters into the conducting-tissue of the pistil, and passes on until it reaches an ovule or undeveloped seed, which it then fertilizes. To investigate this fact, it is necessary to cut a matured pistil from a partially withered flower, subject it to moderate pressure, and mount it in fluid or balsam. The stamens and the pistil of the Dead Nettle are best when mounted in a dry opaque cell; or they may be mounted in balsam, and viewed under the parabolic reflector.

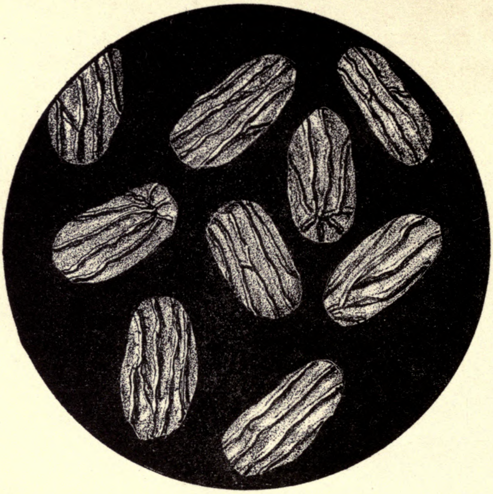

Fig. 45.

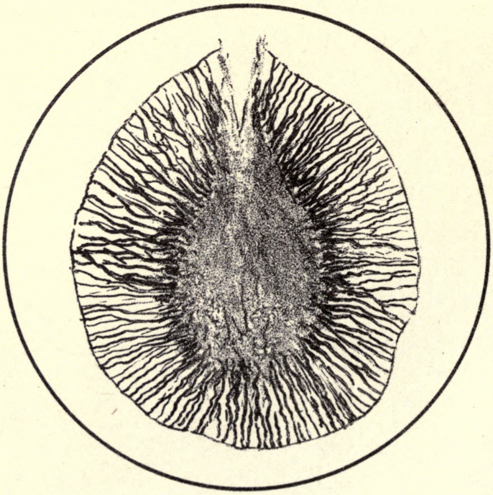

Fig. 46.

Jno. H. Martin, ad nat. del. Dickinson, I

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Fig. 45.—*Seeds of the Least Toad-flax* (Linaria minor), × 20.

The testa of this seed is much furrowed; and there are many seeds partaking of this character, of which the Poppies, Toad-flaxes, &c. contain some of the best examples. Many seeds have also a number of rayed protuberances rising from their surface, as in the Campions, Catchflies, &c. The testa may be separated from the seed and mounted as a transparent object; or the seeds may be mounted in a dry opaque cell. But it is best, if possible, to mount them in both ways, as the real structure is then better seen. Many seeds, when viewed opaquely, have a striking resemblance to the eggs of Moths and Butterflies (see Insects' eggs).

Fig. 46.—*Seed of Eccremocarpus* (Eccremocarpus scaber), × 20.

Winged seeds like the present always present a beautiful structure under the low powers of the microscope. Some of the best forms are *Calosanthes Indica, Paulownia imperialis, Lophospermum scandens, Pentstemon,* &c. Seeds have two skins or coats, called the testa and tegmen; the former and outer membrane (testa) is generally greatly thickened and hardened by the formation of the secondary deposit, as in fig. 48. Sometimes the surface is furrowed, as in fig. 45; occasionally it is quite smooth; and it is rarely covered with spiral-fibrous cells, as in *Collomia* (fig. 47).

Eccremocarpus-seeds are best prepared by boiling in nitric acid 1 part, water 2 parts, which quickly changes the colour to a light brown, when the centre of the seed must be taken out, and the skin well washed and mounted in balsam as usual if wanted for the polariscope, or, if not, in fluid.

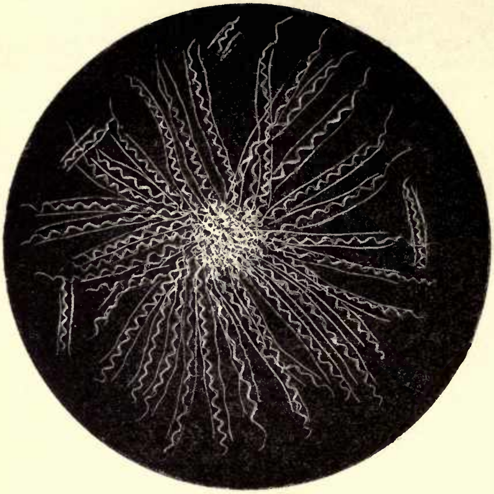

Fig. 47.

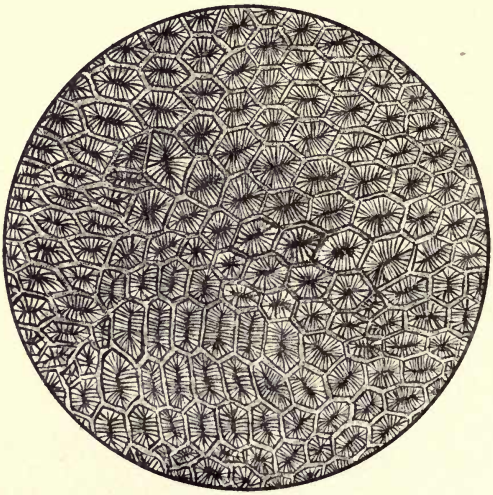

Fig. 48.

H. Mason, ad nat. del. Dickinson, Imp.

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Fig. 47.—*Testa of Seed of Collomia* (Collomia grandiflora), $\times$ 50.

The spiral fibres in the cells of the testa of this seed form a good object in which to observe the extreme elasticity of spiral fibre. The best way to show it is to cut a very small and thin slice from the outside of the seed, to place it on a glass slip, and then add a drop of alcohol to it, and cover with thin glass, next adding water in sufficient quantity to fill up the space left between the glasses. If the object is now viewed under an inch or ½-inch object-glass, the uncoiling of the spiral fibres will be beautifully seen.

It may be mounted in weak alcohol and water—about alcohol 1 part, to water 6 parts.

Fig. 48.—*Testa of Vegetable-Ivory Nut* (Phytelephas macrocarpa), $\times$ 120.

The structure of the testa of the Vegetable-Ivory nut is not unlike that of the nut itself (see fig. 18), the peculiar rayed appearance being also caused by the formation of the secondary deposit. This kind of tissue is often called sclerogen. The drawing might be mistaken for that of the petal of the Geranium, which it greatly resembles; but upon closer examination the cell-wall will be seen to possess a different character (see fig. 37). The husk, or, as it is called, the *testa,* of this nut is of a brownish colour; it may be prepared by grinding down to an extreme thinness, and then mounting in Canada balsam in the usual manner.

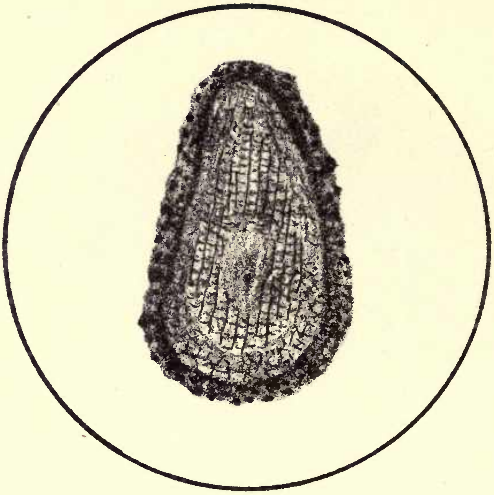

Fig. 49.

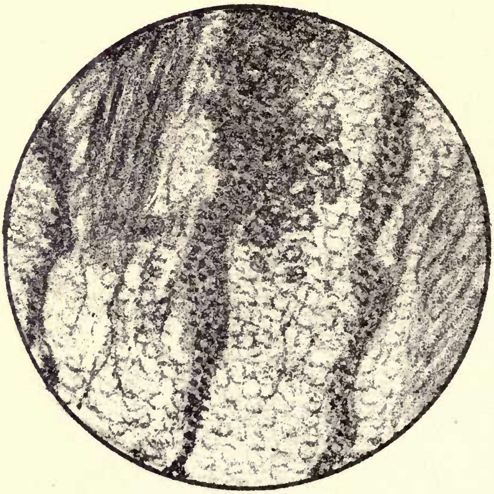

Fig. 50.

Jno H. Martin, ad nat. del.

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Fig. 49.—*Longitudinal Section of a Seed* (Malope grandiflora), × 30.

This drawing has been made to illustrate the chief parts in the composition of a seed. The outer skin or testa is represented by the dark dotted outer part of the drawing; the inner skin or tegmen by the lighter part next to the testa; inside this, represented by the parallel lines with cross markings, is the seed proper, consisting of the young embryo plant, or the life-centre of the seed. The structure and shapes of seeds form a remarkably interesting subject for investigation: for examples of seed-forms, see figs. 45 and 46. The best plan to prepare sections of minute seeds is to imbed them in softened gutta percha, let it harden, and then to cut sections with a fine scalpel. The sections may be mounted in liquid or in Canada balsam.

Fig. 50.—*Section of Seed called "Grains of Paradise"* (Amomum Grana-Paradi'si), × 200.

The structure of this seed, as shown by the drawing, consists of layers of albumen interspersed with the oily or fatty matter, of which the seed contains a large amount. On referring to the drawing, many globules of fat will be seen.

The albumen varies much as to quantity in the different seeds taken from a pod of this plant.

The albumen (or, as it is sometimes called, the perisperm) of seeds must not be confounded with the chemical substance albumen, which is found nearly pure in the white of eggs &c.

Grains of Paradise are much used by publicans and others in the adulteration of beer.

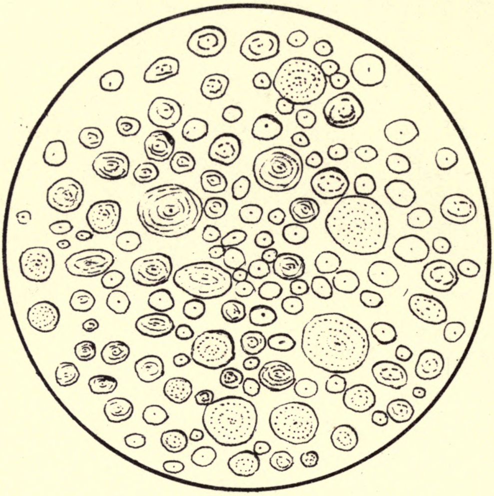

Fig. 51.

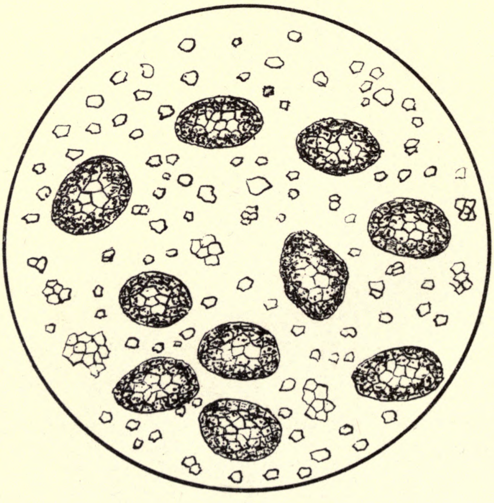

Fig. 52.

Jno. H. Martin, ad. nat. del.

Dickinson,

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Fig. 51.—*Starch from Wheat* (Triticum vulgare), × 350.

Starch may be considered one of the most universal of all the distinct vegetable substances, occurring, as it does, in the form of minute transparent granules in all flowering plants. This may be easily proved by taking a quantity of any herbaceous leaves, stems, &c., bruising them in a mortar until they are beaten into a pulp, then adding more water and straining through flannel; and after the sediment has settled at the bottom of the basin, the presence of the starch may be detected by the application of iodine (see also fig. 53).

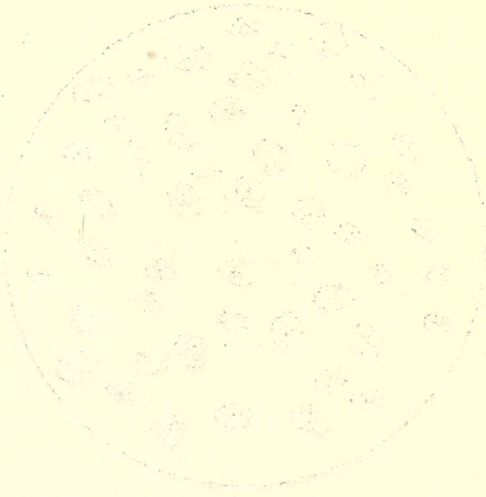
This drawing represents the starch of Wheat, which may be taken as an example of the lenticular or lens-like form of starch.

This starch is best mounted in liquid.

Fig. 52.—*Starch from the Oat* (Avena sativa), × 350.

The chief peculiarity of this starch is, that the small granules or grains are grouped together in round or oval masses. These masses, when broken, have somewhat the appearance of the Rice-starch represented in fig. 53. By this conglomerated appearance, the starch of the Oat may be distinguished from the other common starches found in the different grains, such as those of wheat, maize, barley, &c.

The starch may be mounted in liquid.



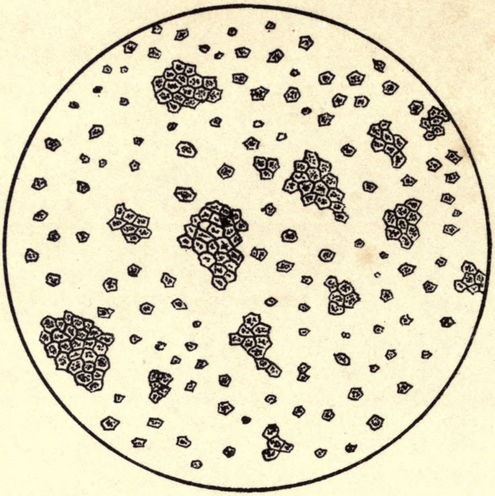


Fig. 53.

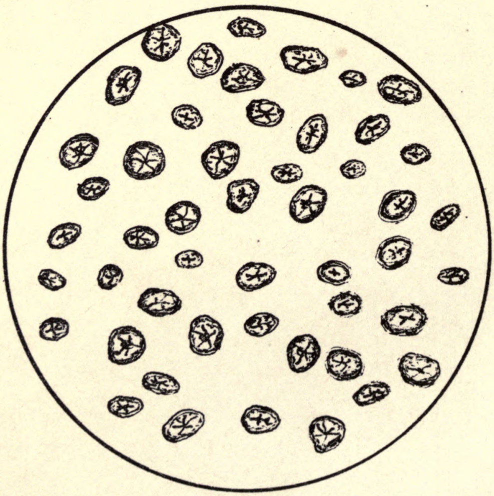


Fig. 54.

Jno. H. Martin, ad. nat. del. Dickinson, Imp.

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Fig. 53.—*Starch from Rice* (Oryza sativa), $\times 450$.

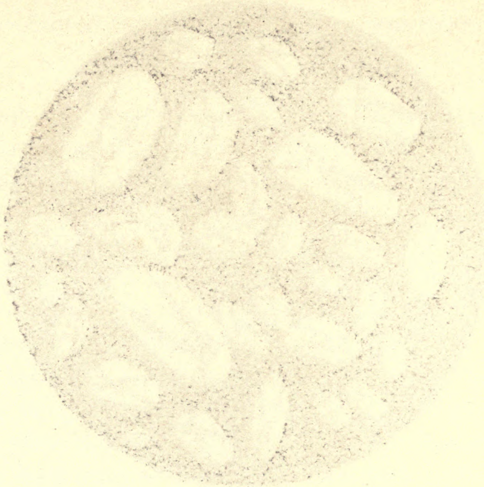
The starch-granules of Rice, like those in the preceding drawing of the Oat-starch, are massed together in a conglomerate form; but in this instance the granules are more irregular in shape, and also greatly pointed, which characteristic gives the peculiar gritty feel to Rice-starch.

The presence of this, or any other kind of starch, may be distinguished in any article adulterated with it, by the iodine test, which is this:—On placing a small quantity of mustard (we will say for instance) under the microscope and adding a small drop of the tincture of iodine to it, if starch in any form is present a number of dark blue or black grains will be seen; these are the starch-granules, which have been so coloured by the iodine.

Fig. 54.—*Starch from Maize* (Zea Mays), $\times 350$.

These granules are taken from the centre of the Indian corn, or Maize as it is generally called. The form is slightly different from that of the granules which are found in the outer part of the grain, which assume more of the hexagonal form, together with a near resemblance to that of cellular tissue, both of which appearances are caused by the pressure of the entire mass upon each individual granule.

This and all the other starches show their structure best when mounted in liquid.



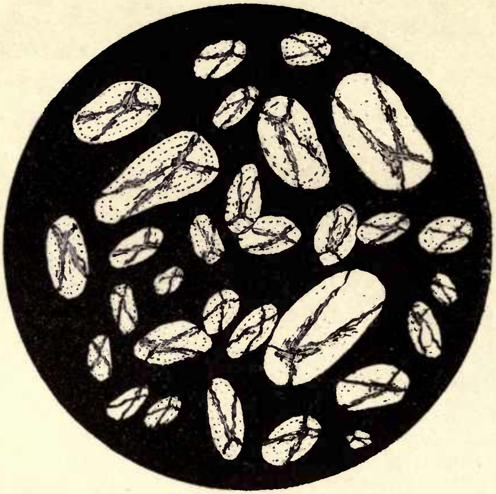


Fig. 55.

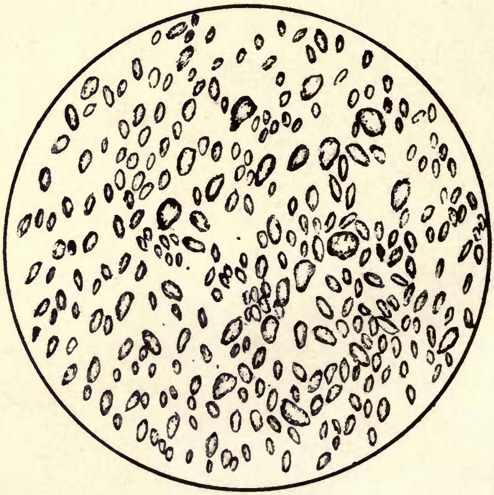


Fig. 56.

Jno. H. Martin, ad nat. del. Dickinson, Imp.

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Fig. 55.—*Starch from the Potato* (Solanum tuberosum), × 200.

This starch is drawn as viewed under the polariscope, and exhibits the black cross which is seen in all large starches when viewed under the polariscope. This makes it easy to distinguish starch from all other substances when it is present in any adulterated article.

Potato-starch forms one of the largest of the starch-granules, and is often used in the adulteration of arrowroot &c. The granules, when mounted in fluid, exhibit the rings or concentric layers of growth, as seen in fig. 51; but when required for the polariscope, they show best when mounted in balsam, or, what is better, in balsam dissolved in chloroform.

N.B. No heat must on any account be used in the mounting of starches, as it destroys their structure.

Fig. 56.—*Starch from the Spanish Chestnut* (Castanea vulgaris), × 350.

Most starches are found of various sizes, which arises from their being in different stages of growth: the structural centre is called the hilum; and around this is deposited, in the course of the growth of the granules, a series of concentric rings, increasing in number according to its age (see fig. 51). A great quantity of starch is found in nuts, and also in most roots and seeds, it being the chief source of support to the young plant. Starch is insoluble in cold water; but upon the application of heat, sulphuric acid, &c., it loses its characteristic structure and becomes converted into a soluble substance called dextrine.

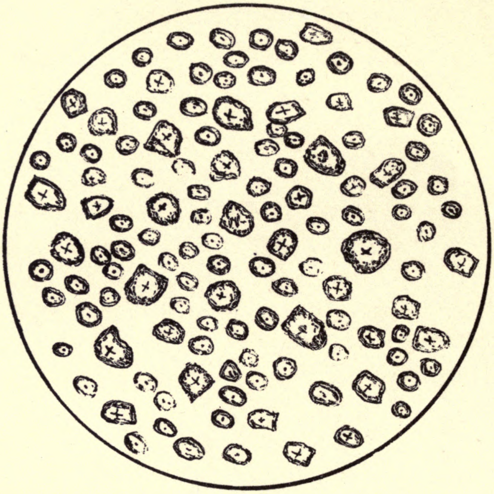

Fig. 57.

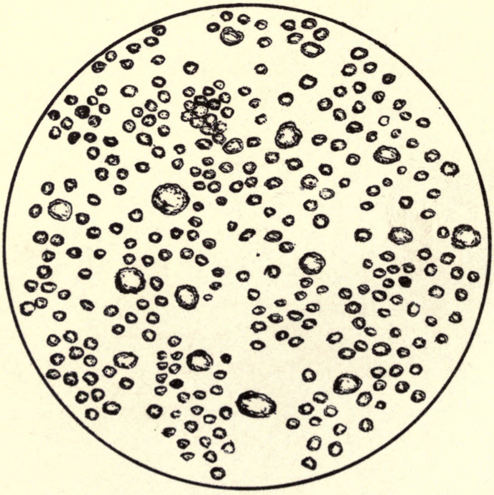

Fig. 58.

Jno. H. Martin, ad. nat. del.

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Fig. 57.—*Starch from Tapioca* (Jatropha Manihot), × 350.

The granules of this starch are chiefly remarkable for their form, and the cross mark at the hilum being rather larger than in most other starches, the hilum generally forming a small black dot. The shape of these granules is also peculiar, being convex at one end and plane at the other.

Starches are best preserved dry when required for future examination.

Fig. 58.—*Starch from the Carrot* (Daucus Carota), × 350.

This starch has been drawn chiefly to illustrate the form of the granules which are found in most of the flowering plants, viz. the Exogens and Endogens. The form is generally globular, although other forms are occasionally found. The presence of these smaller starches is sometimes rather difficult to determine, the iodine test being in this case superior to the polariscope as a means of discovering them. They are also very difficult to measure, many of them being of such minute size that even the iodine fails to make them distinct enough to measure with the micrometer.

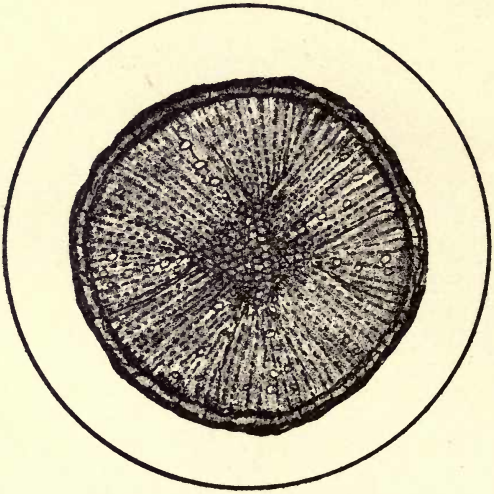

Fig. 59.

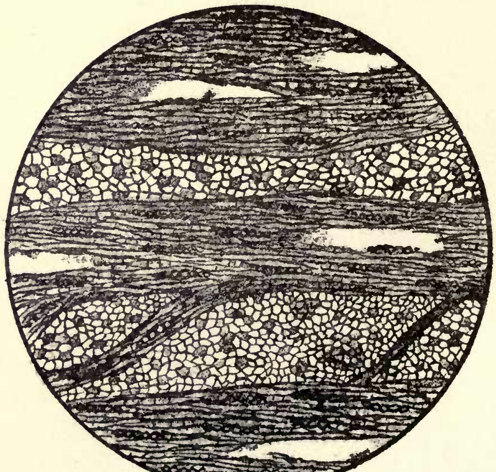

Fig. 60.

Jn.o H. Martin ad. nat. del. Dickinson, Im[p]

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Fig. 59.—*Transverse Section of Bauhinia* (Bauhinia chinensis), ×20. N. O. Leguminosæ, Exogen.

Exogenous are distinguished from endogenous plants by having a bark, concentric annual growths of wood, and a pith in the centre, also for having medullary rays or cells proceeding from the pith to the bark. The bark, wood, pith, &c. will be seen in this drawing; and for a description of an endogenous stem see fig. 72. Prosenchymatous cells, forming woody tissue, are in greater abundance in the Exogens than in the Endogens; but the former contain less vascular and cellular tissue than the Endogens.

Wood-sections are best seen when mounted dry, although Canada balsam may often be used with advantage.

Fig. 60.—*Longitudinal Section of the Wood of the Cork-Oak Tree* (Quercus Suber), ×50. Exogen.

The ducts of this wood seem to be extremely large, and the prosenchymatous or woody cells rather more closely connected than in most woods. The wood of this species of Oak has a thick bark, which is largely used in commerce under the name of cork. This bark is composed of extremely small and at the same time closely packed cells of cellular tissue, which tends to give that fine elastic quality which makes it so useful an article where these qualities are so greatly needed.

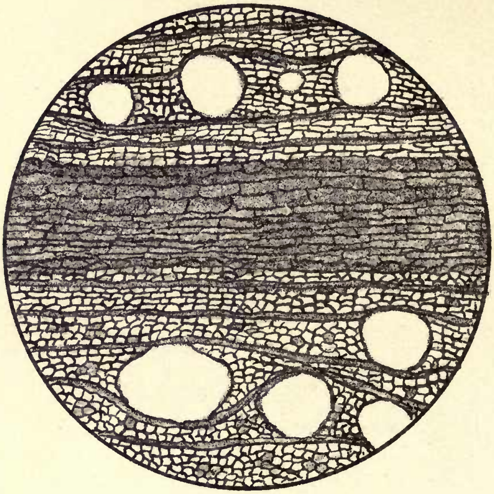

Fig. 61.

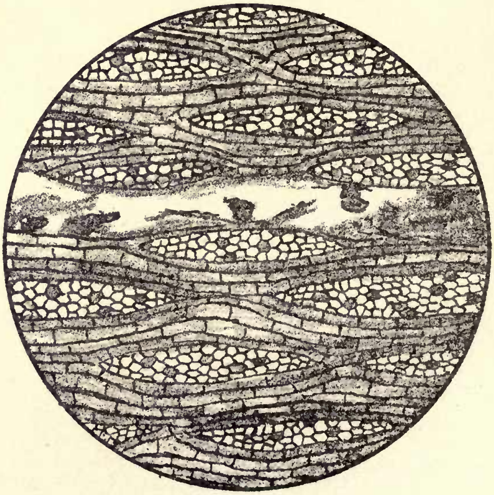

Fig. 62.

Jno. H. Martin, ad nat. del. Dickinson, Imp

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Fig. 61.—*Transverse Section of the Wood of the Cork-Oak Tree* (Quercus Suber), × 120. Exogen.

The large holes seen in this drawing represent the transverse sections of the ducts of this wood; the other parts represent the woody parenchymatous cells, placed amidst the ordinary prosenchymatous tissue of the wood. The large holes give the woods belonging to this genus, which may be represented by this drawing, a distinctive character from those of most of our British woods, their grain generally being much closer (see figs. 68, 69, 70, &c.).

Oak is an extremely durable wood, and is, or rather was, largely used in ship-building &c.

Fig. 62.—*Longitudinal Section of Honduras Mahogany* (Swietenia Mahagoni), × 80. Exogen.

The ducts of this wood seem to be extremely large and very loose in structure. They contain a large quantity of resin, part of which, as left in the duct, may be seen on referring to the drawing. The ordinary prosenchymatous tissue is also of a rather looser structure than is generally found in most other woods.

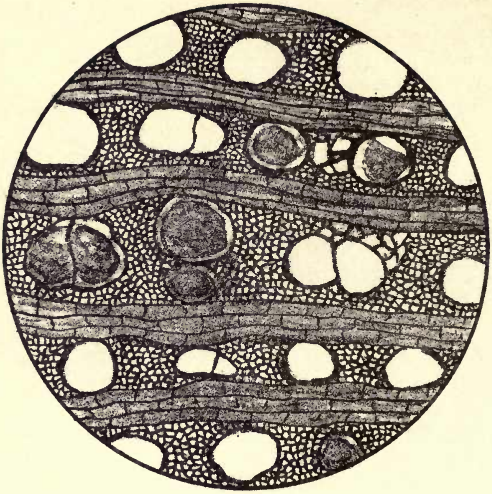

Fig. 63.

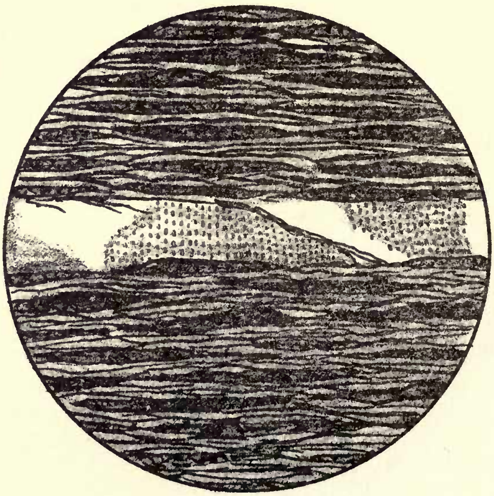

Fig. 64.

Jno. H. Martin, ad. nat. del.

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Fig. 63.—*Transverse Section of Honduras Mahogany* (Swietenia Mahagoni), × 80. Exogen.

This section also shows the resin in its natural position in the ducts. The transverse sections of the ducts and the prosenchymatous tissue also exhibit nearly as open an appearance as seen in the longitudinal sections.

This wood is largely used in commerce.

Fig. 64.—*Longitudinal Section of Alder-wood* (Alnus glutinosa), × 200. Exogen.

The medullary cells are of a very dark and close structure in this wood, which will be seen on referring to the drawing; the prosenchymatous tissue is also of a close nature; but to make up for this, and to allow the juices of the tree to circulate freely, it has rather large ducts.

The wood is extremely useful, having the property of remaining nearly intact for many years under water. It is therefore used for piles &c; it is also used for the production of charcoal &c.

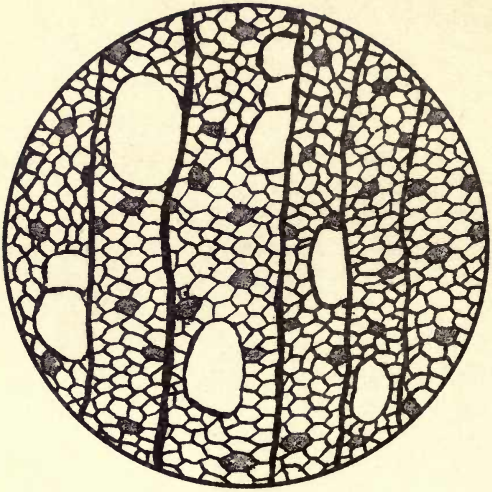

Fig. 65

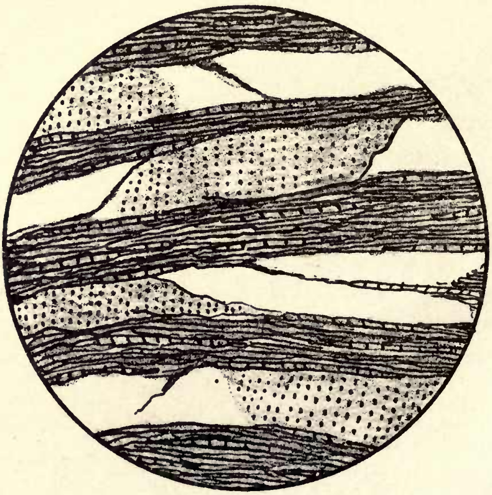

Fig. 66

Jno. H. Martin, ad. nat. del. Dickinson. Imp.

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Fig. 65.—*Transverse Section of Alder-wood* (Alnus glutinosa), × 200. Exogen.

The large ducts of this wood were mentioned in the preceding description; their transverse sections are well illustrated by this drawing. The smaller holes represent the transverse sections of the ordinary prosenchymatous tissue; there are also a few parenchymatous cells. The dark lines represent the transverse sections of the medullary cells.

Fig. 66.—*Longitudinal Section of the Wood of the Willow* (Salix alba), × 120. Exogen.

This wood also has rather large ducts; and in this case they are very numerous. The ordinary prosenchymatous tissue is rather closely packed, and the medullary cells are small and few in number. This wood being of such a light, open, yet strong and durable nature, makes it extremely useful where great elasticity and lightness are required, such as in boat-building, cooperage, basket-manufacture, &c. A valuable tonic medicine called Salicine is extracted from the bark of this wood; its properties are nearly allied to those of quinine.

Fig. 10 represents a more highly magnified section of this wood.

Fig. 65.—*Transverse Section of Alder-wood* (Alnus glutinosa), × 100. Exogen.

The large ducts of this wood were mentioned in the preceding description; their transverse sections are well illustrated by this drawing. The smaller holes represent the transverse sections of the ordinary prosenchymatous tissue; there are also a few parenchymatous cells. The dark lines represent the transverse sections of the medullary cells.

Fig. 66.—*Longitudinal Section of the Wood of the Willow* (Salix alba), × 120. Exogen.

This wood also has rather large ducts; and in this case they are very numerous. The ordinary prosenchymatous tissue is rather closely packed, and the medullary cells are small and few in number. This wood being of such a light, open, yet strong and durable nature, makes it extremely useful where great elasticity and lightness are required, such as in boat-building, cooperage, basket-manufacture, &c. A valuable tonic medicine called Salicine is extracted from the bark of this wood; its properties are nearly allied to those of quinine.

Fig. 10 represents a more highly magnified section of this wood.

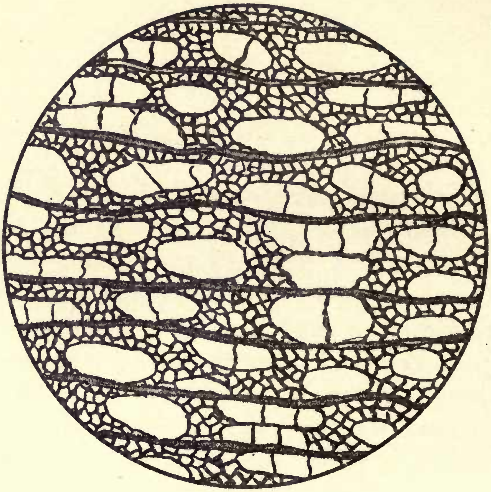

Fig. 67

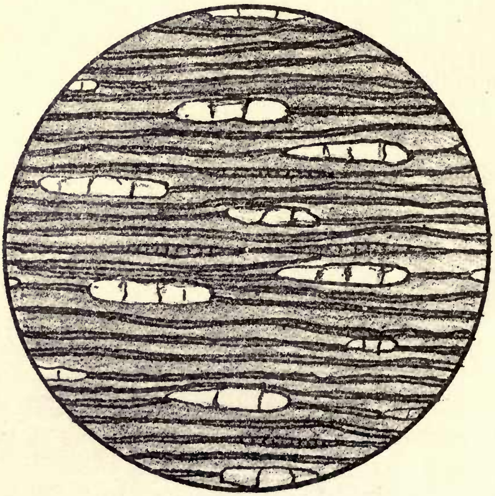

Fig. 68

Jno. H. Martin, ad. nat. del.

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Fig. 67.—*Transverse Section of the Wood of the Willow* (Salix alba), × 120. Exogen.

The transverse section of this wood shows the very large number of ducts that the wood contains. The smaller holes represent the transverse sections of the ordinary prosenchymatous cells, and the dark lines represent the transverse sections of the medullary cells. As was mentioned at fig. 66, this wood is remarkable for its extreme elasticity, the cause of which is evident on referring to the drawing; the ducts being numerous and large, allow for the extra pressure of the prosenchymatous, or woody fibre, when the wood is bent. Both the ducts and the woody fibre are also greatly strengthened by the small yet strong and frequently occurring medullary cells.

Fig. 68.—*Longitudinal Section of Norfolk-Island Pine* (Araucaria excelsa), × 120. N. O. Coniferæ.

This wood has been chosen chiefly to illustrate that of the N. O. Coniferæ, which, unlike most other woods, is destitute of the ducts. The transverse sections of the prosenchymatous cells are generally of an hexagonal form; while the longitudinal sections exhibit, under a moderate power, glands or pits seated in the prosenchymatous or woody cells, as shown in fig. 14. The large holes in the drawing of this wood represent the transverse sections of the medullary cells.

Many of the cuticles of the leaves of the Coniferæ exhibit interesting structures, an instance of which was shown in fig. 24.

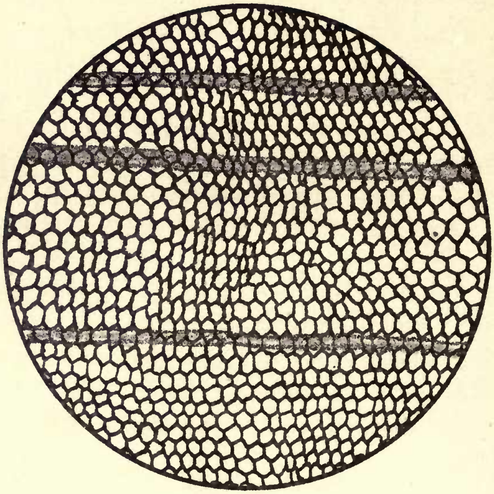

Fig. 69.

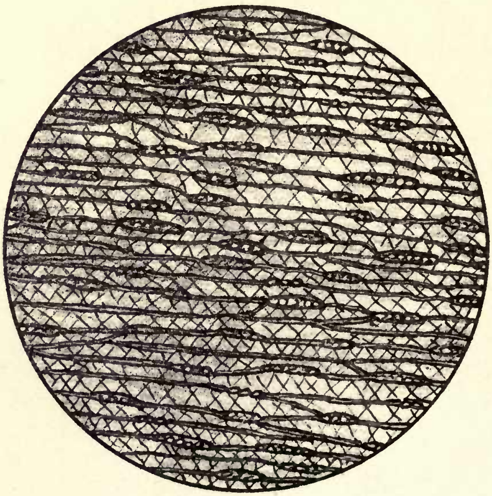

Fig. 70

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Fig. 69.—*Transverse Section of the Wood of the Norfolk-Island Pine* (Araucaria excelsa), × 120. N. O. Coniferæ.

This network, consisting of the transverse sections of the woody tissue, exhibits the hexagonal form which the cells have taken from the even pressure exerted on all sides. The dark lines represent the transverse sections of the medullary cells.

The members of this natural order are of great service in the arts and manufactures, their woods being largely used in commerce; and most of the species secrete resin, turpentine, &c. *Pinus larix* (the Larch) yields Venetian turpentine. The Cedar of Lebanon also belongs to this natural order.

Fig. 70.—*Longitudinal Section of the Wood of the English Yew* (Taxus baccata), × 120. N. O. Coniferæ.

The texture of this wood is also very close and hard, the prosenchymatous cells being even smaller than those of the Norfolk-Island Pine; the medullary cells are also close in structure, although rather numerous.

The fine grain and beautiful shading of some parts of this wood make it useful in turnery and fancy woodwork. It is also used for bows.

Articles made from this wood are exempt from the ravages of insects &c.

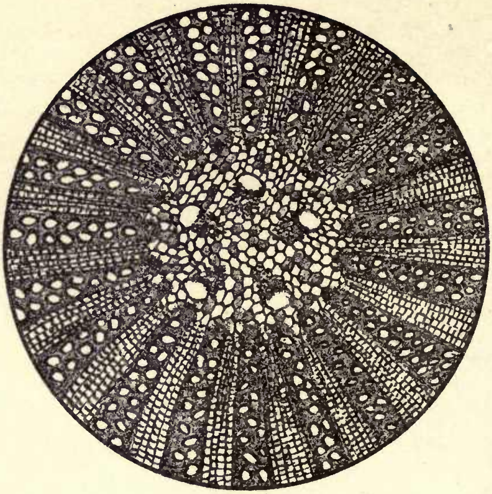

Fig. 71

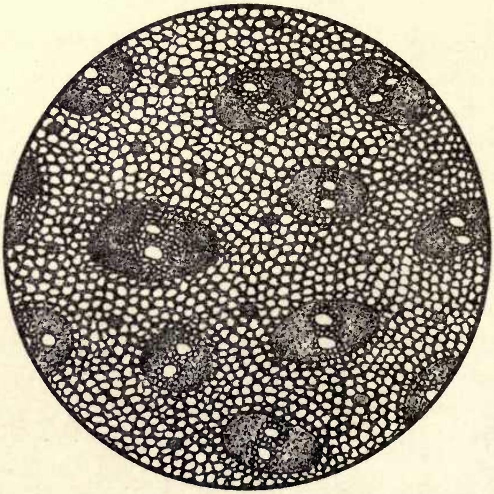

Fig. 72

Jno H. Martin, ad nat del.

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Fig. 71.—*Transverse Section of Malacca Pepper Stem* (Piper nigrum), × 40.

The section of this stem has been taken the better to illustrate some of the remarks made in the description of fig. 59. Being a section of an exogenous stem, it has the central cellular pith, the medullary rays proceeding from the pith to the bark or outer skin, and also rays of the ordinary prosenchymatous or woody tissue. The five larger holes are transverse sections of the ducts.

Fig. 72.—*Transverse Section of the Stem of the Cocoa-nut Palm* (Cocos nucifera), × 20. Endogen.

Endogenous plants may be distinguished from Exogens by their stems being destitute of medullary cells and concentric layers of annual woody growth, also by their stems being almost composed of cellular tissue—although in some plants the vascular tissue is largely represented, as, for instance, in this Palm, the oval parts in the drawing representing the vascular tissue seated in a mass of parenchymatous cells. The large dotted ducts which are generally found in the exogenous woods are also absent. Many Endogens are met with in which the centre of the stem is entirely absent, as in the Grasses &c.

This section is best seen mounted in fluid.

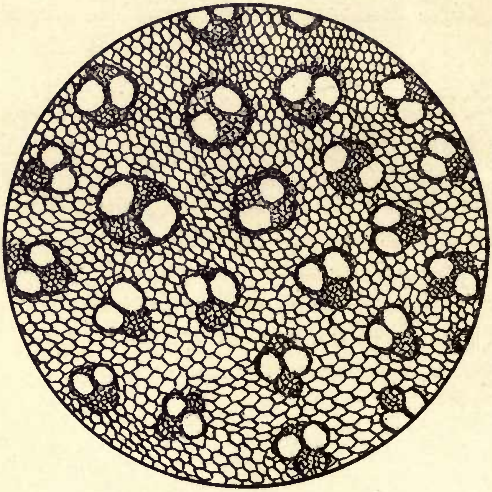

Fig. 73

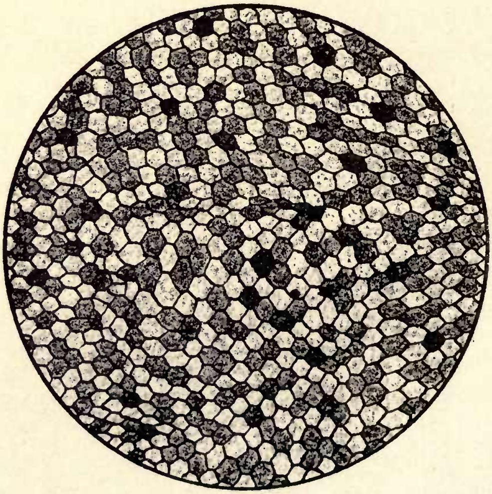

Fig. 74

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Fig. 73.—*Transverse Section of the Stem of Sarsaparilla* (Smilax Sarsaparilla), × 40. Endogen.

The drawing illustrates another endogenous stem, as seen in the common Sarsaparilla of commerce. The clusters of large holes represent the bundles of vascular tissue, and the network the parenchymatous or cellular tissue. The Sarsaparilla plant belongs to the N. O. Smilaceæ—a small Natural Order, but one containing some valuable plants.

Fig. 74.—*Transverse Section of* Pilea smilacifolia, × 40. Exogen.

This section of the pith of one of the exogenous plants of the Natural Order Urticaceæ has been taken to show the transformation of many of the parenchymatous cells, by a process of secondary deposit, into thickened cells having a tendency to form wood, woody fibre, or prosenchymatous cells, as will be seen in observing this and other herbaceous plants.

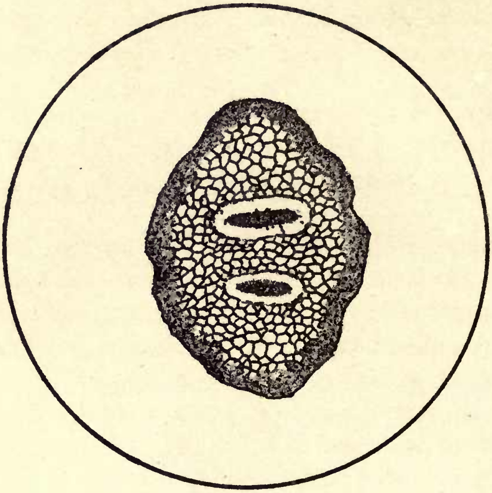

Fig. 75

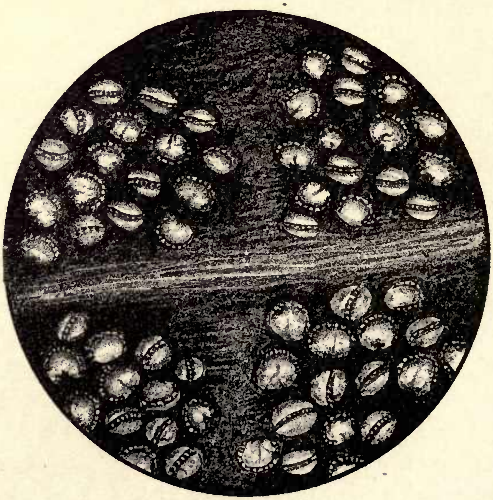

Fig. 76

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Fig. 75.—*Transverse Section of the Stem of a Lycopodium* (Lycopodium inæqualifolium), × 20. Acrogen.

A section of this club-moss has been figured to illustrate the structure of an acrogenous stem, as differing from the exogenous and endogenous stems shown in figs. 59, 71, 72, 73, &c.

On the outer part of the stem a thin layer of cells, which have been thickened by secondary deposit and dotted, will be seen—and inside this formation a loose layer of cellular tissue, surrounding bundles of scalariform tissue. For another example of an acrogenous stem see fig. 11. Lycopodiums appear to be closely allied to some Ferns as regards the position &c. of their seed-vessels. The creeping *Selaginella* of our Wardian cases belongs to this Natural Order.

The transverse and other sections of this plant may be mounted in fluid or glycerine jelly.

Fig. 76.—*Fructification of a Fern* (Polypodium vulgare), × 40.

From the various species of British and foreign Ferns and Mosses some of the most beautiful and instructive objects may be taken by the microscopist and botanist for their cabinets. The present drawing shows the naked sori for which this genus of Ferns is remarkable, as the sori, or groups of seed-vessels as they may be called, of Ferns are generally covered with a cellular membrane or skin of different shapes. Most species have a reniform or kidney-shaped covering, or indusium as it is called (see fig. 77). The masses of sori generally occur on the back of the fertile fronds, although in some cases they are found on the margins, as in the Maiden-hair Fern (*Adiantum*); and sometimes they are placed alone upon stalks, as in the Osmunda Fern (fig. 79), in which case they form capsules.

This object is best mounted in a dry opaque cell.

Fig. 74.—*Transverse Section of the Stem of a Lycopodium* (Lycopodium inequalifolium), ×20. Acrogen.

A section of this club-moss has been figured to illustrate the structure of an acrogenous stem, as different from the exogenous and endogenous stems shown in figs. 69, 71, 72, 73, &c.

On the outer part of the stem a thin layer of cells, which have been thickened by secondary deposit and dotted, will be seen—and inside this formation a loose layer of cellular tissue, surrounding bundles of scalariform tissue. For another example of an acrogenous stem see fig. 11. Lycopodiums appear to be closely allied to some Ferns as regards the position &c. of their seed-vessels. The creeping Selaginella of our Wardian cases belongs to this Natural Order.

The transverse and other sections of this plant may be mounted in fluid or glycerine jelly.

Fig. 75.—*Fructification of a Fern* (Polypodium vulgare), ×10.

From the various species of British and foreign Ferns and Mosses some of the most beautiful and instructive objects may be taken by the microscopist and mounted for their cabinets. The present drawing shows the naked sori for which this genus of Ferns is remarkable, as the sori, or groups of seed-vessels as they may be called, of Ferns are generally covered with a cellular membrane or skin of different shapes. Most species have a reniform or kidney-shaped covering, or indusium as it is called (see fig. 77). The masses of sori generally occur on the back of the fronds, although in some cases they are seen on the margin, as in the Maiden-hair Fern (Adiantum); and in others they are placed alone upon stalks, as in the Osmunda Fern (fig. 73), in which case they form capsules.

This object is best mounted in a dry opaque cell.

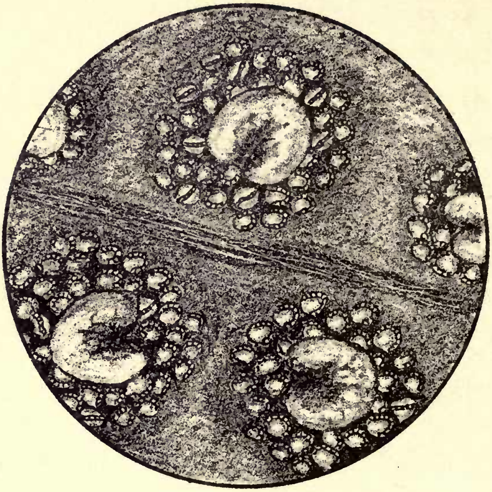

Fig. 77

Fig. 78

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Fig. 77.—*Fructification of the Male Fern* (Lastrea Filix-Mas), × 25.

In this drawing the reniform indusium or covering for the sori will be well seen. The sporanges situated under the indusium have a small stalk, differing in length according to the species of Fern; by this they are slightly fixed to the surface of the frond. For their shape &c. when much magnified, see fig. 78.

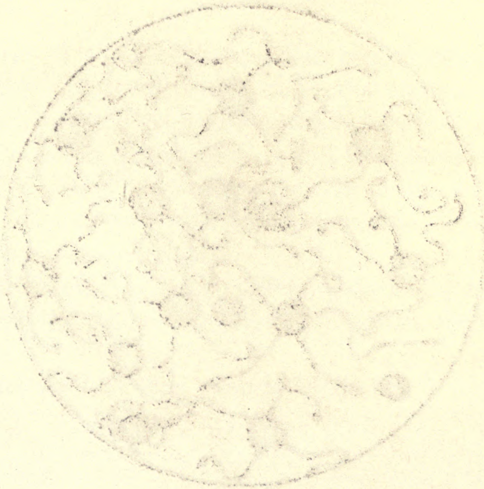
On the stipes or stalks of the fronds of Ferns beautiful-shaped scales often occur; for an example see fig. 26.

Fig. 78.—*Spores and Spore-cases of the Brake Fern* (Pteris aquilina), × 120.

This object, as seen under the parabolic reflector, exhibits the sporanges or spore-cases in the act of discharging the spores. Around the outer side of the cases a ring will be noticed, which is called the annulus. This, being very elastic, when the sporange arrives at maturity breaks at a part of the circumference, and by its elasticity ruptures the case, and scatters the spores around.

Some of these, dropping on a smooth damp surface, grow into a kind of minute leaf, called the prothallus. In this prothallus, at an early period of its growth, appear the reproductive organs. The frond is then fertilized, and grows until the sori appear, and when these are ripened the frond dies off. Such, in a few words, is the life and growth of Ferns.

The sporanges and spores are best mounted in balsam.



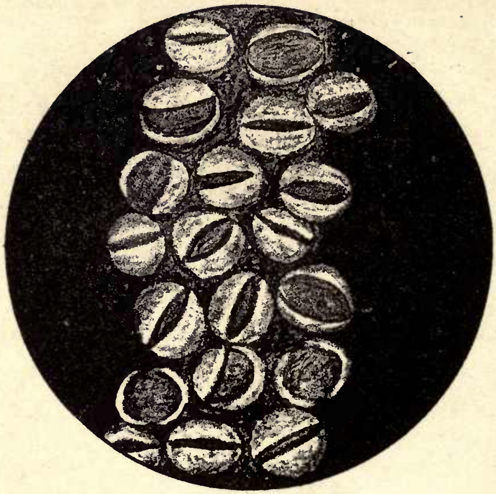


Fig. 79

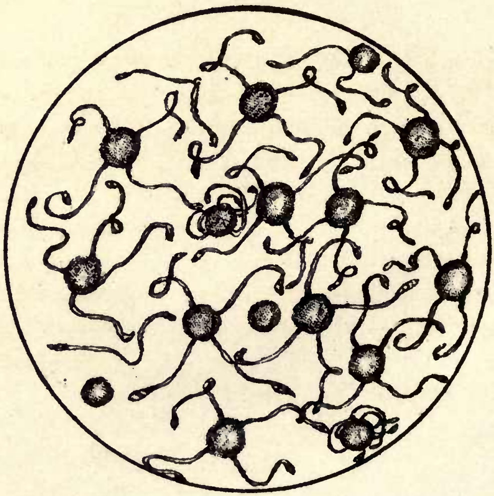


Fig. 80

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Fig. 79.—*Capsules of the Flowering Fern or King of Ferns* (Osmunda regalis), ×20.

The spore-cases or capsules of this are entirely different from those of most other Ferns, being of a subglobose shape and opening vertically.

The capsules are borne on the fertile fronds in clusters, placed upon stalks.

Fig. 80.—*Spores of an Equisetum* (Equisetum fluviatile), ×120.

The spores of the Equisetaceæ are remarkable for their hygrometrical properties, which cause the elaters or curved fibres to curl up when subjected to the influence of moisture. Some of the spores in the drawing will be noticed in the act of curling. In fact they are so sensitive to the least moisture, that I doubt not, with observation, this object might be used as a natural barometer.

The siliceous cuticles of the different species of *Equisetum* are also good objects, when mounted in balsam, for the polariscope.

The spores are best seen when mounted dry.

Fig. 81

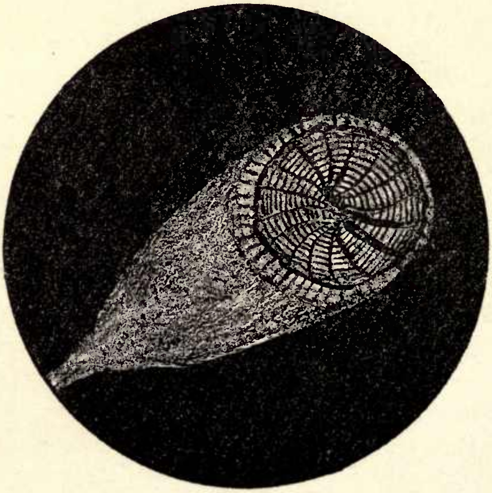

Fig. 82

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Fig. 81.—*Capsule of a Moss in the act of discharging its Spores* (Tortula subulata), × 20.

Mosses are divided into two great sections, called Acrocarpi and Pleurocarpi,—Acrocarpi signifying that the capsule borne on the fruit-stalk or seta terminates the moss, and Pleurocarpi that the fruit-stalk springs from the side of the stem of the moss.

These groups are again divided, according to the structure of the peristome, into Aploperistomi and Diploperistomi. The drawing shows the single peristome (section Aploperistomi) in the act of discharging the spores. It is drawn as seen under the parabolic reflector.

The genus *Tortula* has been so called from the spirally twisted peristome, which will be seen in the drawing; it is the most common of all the genera of Mosses, and the species are chiefly found on walls, very rarely on banks, trees, &c.

The object may be mounted in balsam.

Fig. 82.—*Capsule and Peristome of a Moss: opaque view* (Funaria hygrometrica), × 20.

The division Diploperistomi is represented by this drawing, although a better view of the double peristome will be seen in fig. 84. The seta of this Moss has the property of twisting itself upon the application of water, from which property it has gained the specific name of *hygrometrica*. It is one of our commonest Mosses, being found on the top of nearly all old walls &c.; it is also very commonly found growing where a fire has lately deposited wood-ashes. A longitudinal section of the young green capsule of this Moss is a good subject to show the position &c. of the columella (see fig. 83).

The ripe capsule, as shown in the drawing, is best mounted in a dry opaque cell.

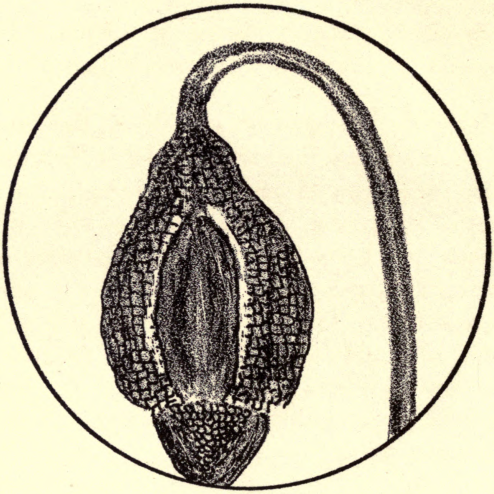

Fig. 83

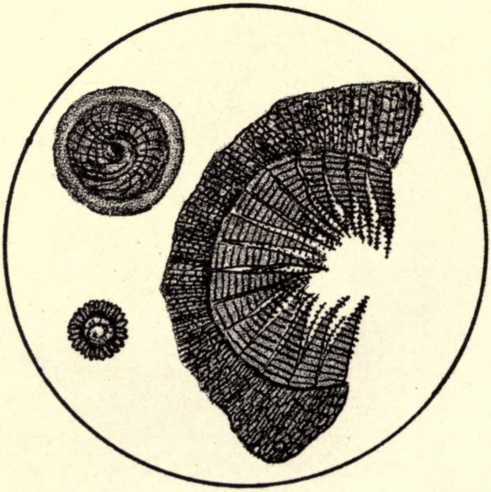

Fig. 84

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Fig. 83.—*Section of a young Capsule of a Moss, showing Columella &c.* (Funaria hygrometrica), × 50.

Any quantity of the young green capsules of this Moss may be collected for examination in the months of February and March, as they then show the columella, seen in the centre of the drawing of the young capsule. Around this columella are clustered the spores when the capsule is mature; at present the spores are undeveloped. The best plan of mounting this object is as follows: take a young capsule, plunge it into a small quantity of liquid India-rubber, let it dry until a slice can be taken, then slice with a fine scraper in the direction from the seta to the operculum, wash in alcohol, and mount in fluid or glycerine-jelly.

Fig. 84.—*Dissections of a Moss, showing the Peristome, Operculum, and Annulus* (Funaria hygrometrica), × 20.

These dissections, together with figs. 81, 82, 83, and 85, comprise the chief parts of Mosses as named in a botanical description of any species. The larger piece in the drawing has 16 teeth and 16 cilia (not all visible), which compose the two rows, and are both included under the title of the peristome. The largest round piece is called the operculum, or cap. This in all cases covers the peristome with its delicate teeth, until the spores in the capsule are mature, when it falls off, and in the act often loosens the annulus, the small circle shown in the drawing. If the annulus is not thrown off then, it soon follows the operculum, and no doubt, by its elasticity, aids greatly in scattering the spores around the parent moss; the hygrometrical properties of many of the setæ of Mosses also assist the other organs in this important provision for the increase of the species.

The objects are best mounted in fluid.

Fig. 85

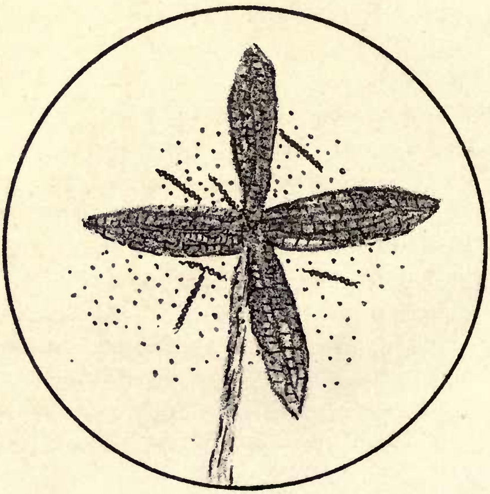

Fig. 86

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Fig. 85.—*Reproductive Organs of Moss* (Bryum hornum), × 60.

The reproductive organs, the antheridia and archegonia, of Mosses answer somewhat in their functions to the stamens and pistil of the flowering plants (see fig. 44), although of course there is a difference in their mode of action. The antheridia, or male organs, are generally of an oblong-oval shape (see the drawing), and the archegonia, or female organs, flask-shaped; the latter are developed by successive changes into a capsule borne on a seta or stalk, and containing in its centre a columella surrounded by spores.

The study of the fructifying organs of Mosses will be found exceedingly interesting; and in the spring of the year they are not difficult to find, at least to any person having a will to do so.

They may be mounted in many ways; but I prefer fluid.

Fig. 86.—*Capsule of Two-horned Scale-Moss* (Jungermannia bicuspidata), × 30.

The Jungermanniæ seem to form the link between the Mosses and the Lichens, although they differ from each in many respects. The chief characteristics of the Jungermanniæ are the leaves being bifarious, and often possessing stipule-like bodies called amphigastria (see fig. 87), and sporanges bursting by four valves. They are destitute of a columella, but possess curious bodies, called elaters, mixed with the spores; these elaters are like two springs joined, in their opposite spiral direction. They will be noticed in the drawing, also the four valves of the capsule or sporange.

The capsules, elaters, &c. are best mounted in balsam.

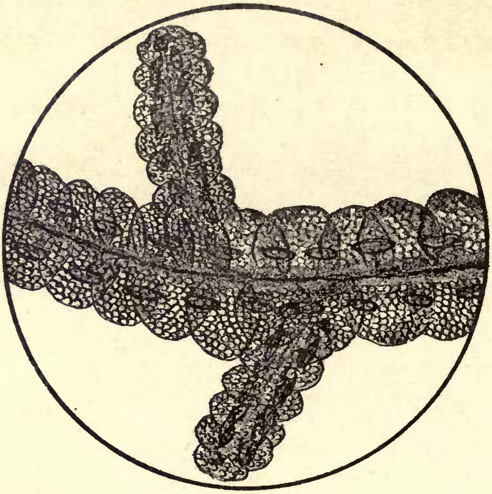

Fig. 87

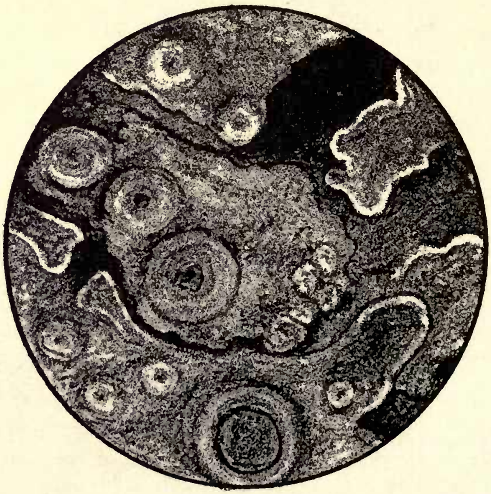

Fig. 88

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Fig. 87.—*Tubercled Scale-Moss* (Frullania dilatata), ×20.

This Scale-moss belongs to the Jungermanniæ, but, unlike the preceding genus, the capsules are sessile; that is, seated close to the stem. The capsules are absent in this figure, as it has been drawn chiefly to illustrate the bifarious leaves, and the stipule-like bodies called amphigastria, which bodies, it will be noticed, are placed in rows on each side of the stem. This plant is common on the bark of many trees, although it may not often be noticed by casual observers on account of its being of a brown colour.

It is best when mounted in fluid or glycerine-jelly.

Fig. 88.—*Yellow Wall-Lichen* (Parmelia parietina), ×20.

This is one of the commonest of our British Lichens. It is found chiefly on walls, palings, &c., and may be known by its yellow colour (although it is often of a greyish tint when growing in the shade)—and by its having also large yellow apothecia, or cups, of which magnified views are given in this drawing; the other part is called the thallus. This part, although different in shape, would slightly answer to the young fronds of ferns, it containing within its structure all the requisite organs for its further propagation. The organs of fructification are similar to those of the Fungi.

Although common, they are plants but little studied—in fact, even less so than Mosses. Here microscopists will find a good and useful field for their labours of research.

Most of the Lichens, when required for the determination of their species only, are best mounted in a dry opaque cell; when their parts are wanted, they are best mounted in fluid or balsam.

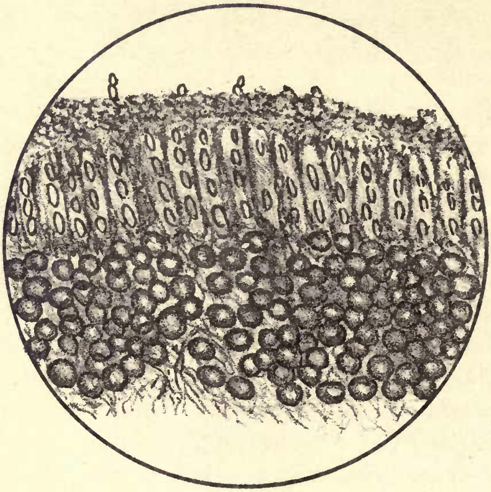

Fig. 89

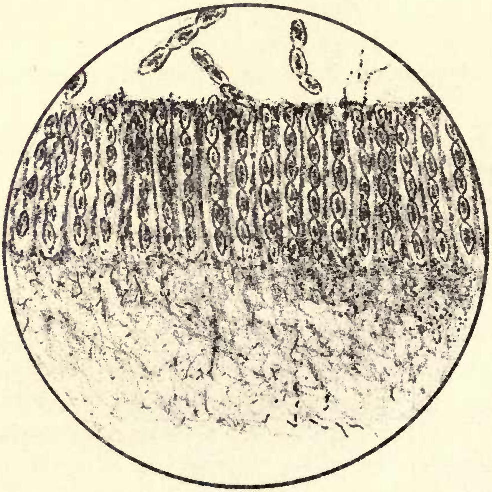

Fig. 90

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Fig. 89.—*Transverse Section of the Apothecia of a Lichen* (Parmelia parietina), × 200.

It will be seen from this drawing that, although unlike in their general outward appearance, Lichens much resemble the Fungi in many of their organs. The frond, or, as it is called in this case, the thallus, is composed of four parts, which the drawing represents,—the top consisting of a thin layer of the coloration-cells; next to this are the sacs or thecæ, containing the spores, and next to these are the gonidia or globular bodies. These bodies appear to answer many of the purposes of the buds of the higher flowering plants, and are, perhaps, the most useful in its propagation. Next to these are the filaments, some of which answer the purpose of roots; and amidst the upper layers the gonidia are produced.

A section of the apothecia should be cut with a fine scalpel, soaked in alcohol for a minute, and then taken out and dried under pressure, and mounted in balsam as usual, but without heat.

Fig. 90.—*Transverse Section of a Fungus, so-called Scarlet Cup-Moss* (Peziza coccinea), × 100.

The drawing of this Fungus has been taken to show the difference between the parts and those of a section of a Lichen as represented in the preceding figure. The gonidia are wanting, and the coloration-cells, instead of being only a superficial layer, as in the section of the *Parmelia,* are mixed with the asci. Beneath these is the mycelium, consisting, in this case, of a number of fine felted filaments, producing a leathery kind of thallus (mycelium). It will be noticed, from these slight descriptions, that in their organic parts Lichens are not unlike the Fungi.

Sections may be treated in the same manner, and mounted in balsam, although in many cases I prefer fluid.

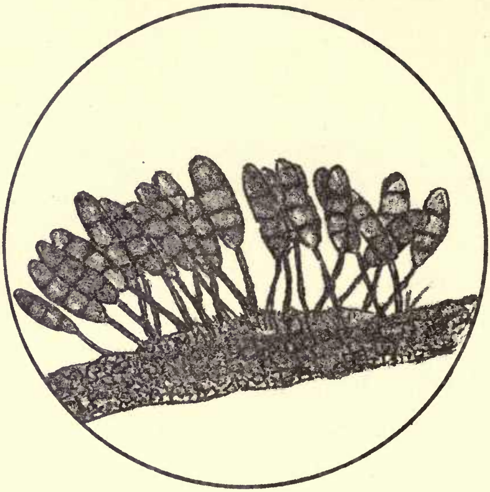

Fig. 91

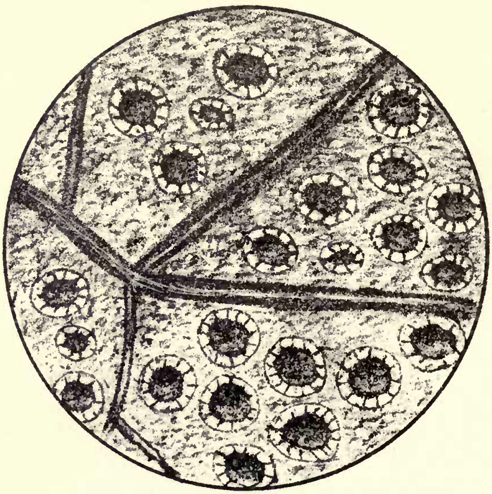

Fig. 92

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Fig. 91.—*Bramble-leaf Brand* (Aregma bulbosum), × 350.

This, together with many other objects mentioned in this book, are not at all uncommon, and for that very reason I have taken it; so that it may be seen that the rarest objects are not always the most beautiful, nor yet even the most instructive.

The reader has, no doubt, often noticed in the autumn that the leaves of the Bramble are spotted with small black dots; these dots, when magnified, resolve themselves into a number of oblong spores seated on stalks. These spores appear to be divided into three or more cells, and they may be taken as an example of the general structure of the brands, which, although not so destructive as the Rusts &c., still in some cases do much harm to the farmer's crops.

The best plan of mounting these brands is to cut a very thin section through the leaf containing the brand, and then to mount it in a shallow cell in the essential oil of lemon.

Fig. 92.—*Cluster-cups on the Leaf of the Pilewort* (Æcidium Ranunculacearum), × 20.

Cluster-cups are another kind of microscopic Fungi, also common on many of our British plants; for instance, on the Common Spurge (*Euphorbia amygdaloides*) of our hedges they will be noticed in large numbers. To make out their structure, the leaves on which they grow may have sections cut through them, and also the cuticle of the leaf may be torn off. The spores are large in most of the species, and when young will be seen seated in the cups, or, as they are called, the peridia.

These objects, when entire, are best when mounted dry; but the sections &c. are best mounted in fluid. I prefer oil of lemon.

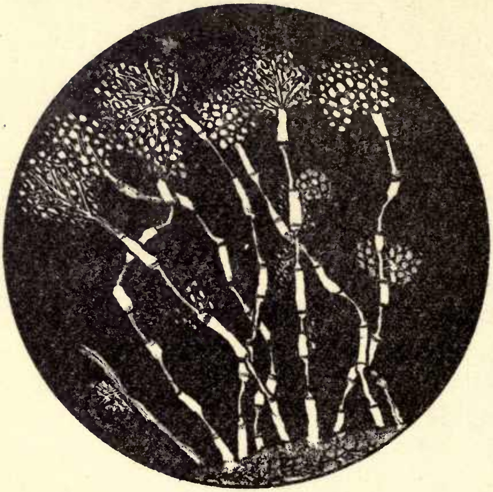

Fig. 93

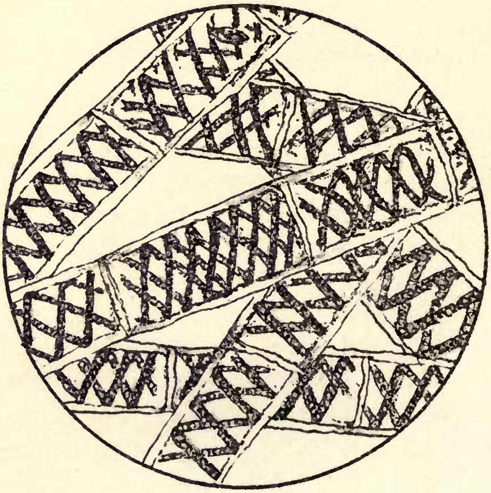

Fig. 94

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Fig. 93.—*Mould from a Decayed Leaf of Begonia* (Botrytis vera), $\times 40$.

Another kind of microscopic Fungi are the moulds, of which this species is an example; they are chiefly found on decaying vegetable substances.

The disease called the potato-blight is a mould, and belongs to this genus. Without doubt the spores of many of the moulds enter the stomata of the leaves of plants, and are thus carried with the sap into all its parts; and if there is any inherent weakness which would be favourable to their growth, they increase accordingly. That the spores of Fungi thus enter into the circulation of plants may be shown by mould being found in the interior of apples &c. Moulds and various Fungi may be cultivated in a damp atmosphere, produced by covering damp sand or earth with a bell glass, such as those used by gardeners, the sand being kept constantly moist.

The different moulds show best when mounted in a deep dry cell.

Fig. 94.—*A Species of Confervoid Algæ* (Spirogyra decimina), $\times 120$.

Of this species of Conferva, collected at Hollingbourne, near Maidstone, the spiral bands are two, crossing each other so as to present the appearance of a repetition of the letter X joined together; and from this characteristic it is that the species is named. The genus also is named *Spirogyra* from the spiral bands which are always found, generally numbering from one to four, according to the species. Some of the species being rather common, and more particularly their remarkable appearance, have caused them to be well studied. The process of conjugation of the Confervæ may be well seen in ripe specimens of this genus.

It is best mounted in a suitable fluid.

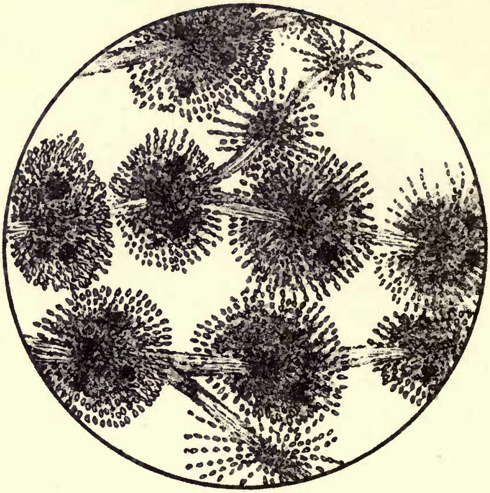

Fig. 95

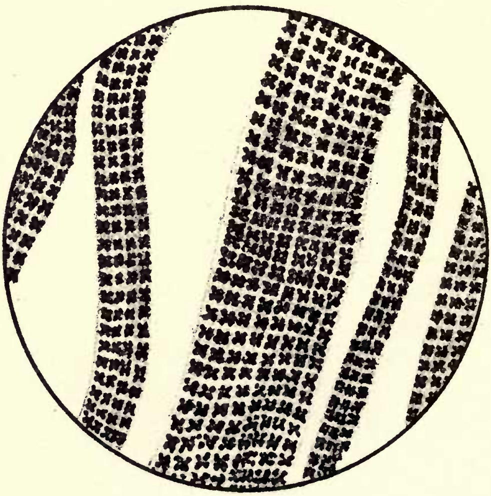

Fig. 96

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Fig. 95.—*A Species of Confervoid Algæ* (Batrachospermum moniliforme), × 60.

This species may be considered one of the most beautiful of all the Confervoid Algæ. It is found in clear and slow-running streams. The colour is generally green, yellow, or red; and it may be distinguished by its fine sprays, somewhat resembling one of our common red Seaweeds (*Plocamium coccineum*). The tufts of chains of the oval spores occur in whorls at intervals in the stem of the plant.

The object is best mounted in fluid.

Fig. 96.—*A Species of Conferva* (Prasiola calophylla), × 100.

The chief character of this rare form of Conferva is that the cells are placed in groups of four, in regular lines with intercellular walls. The increase of the plant appears to be by the solution or destruction of the filaments by the process of decay, when the cells, which seem to be the spores also, are left free, and so by their growth increase the species. The reproduction of this Conferva appears to have been at present little studied.

The object is best when mounted in fluid.

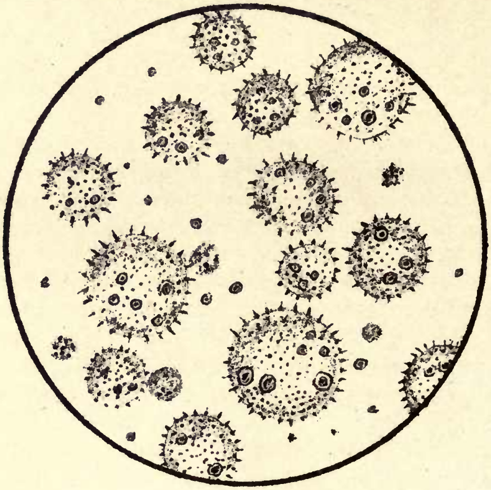

Fig. 97.

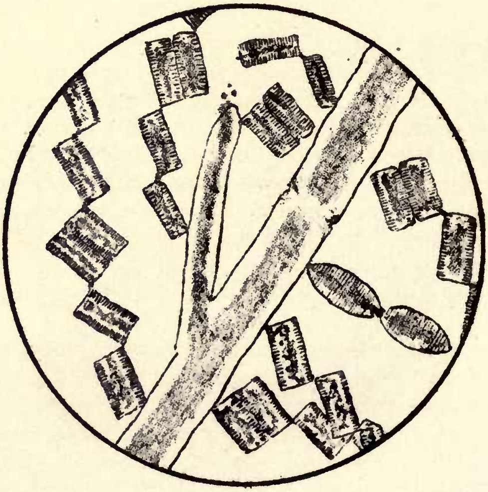

Fig. 98.

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Fig. 97.—*A Species of Confervoid Algæ* (Volvox globator), ×40.

It is only within the last few years that this microscopic organism has been thoroughly examined, and found to be one of the Confervoid Algæ, before which time it was thought to be an infusorial animalcule. On the examination of fresh specimens (which may often be procured in pools, on open heaths, fields, &c., and which appear to the naked eye as minute globular bodies, moving with a rolling motion) under a low power, say 1 inch, the cause of motion will be seen to consist in a multitude of minute hairs (or cilia, as they are called) with which the bodies are studded; these act as oars. In the interior a number of small green bodies will be seen; these are the young volvoces, and, on the rupture of the membranous sac of the parent plant, escape, grow, and increase. They are preserved with difficulty so as to show the cilia. They appear to keep tolerably well when mounted in a shallow cell in weak alcohol and water.

Fig. 98.—*A Diatom in its Natural State on a Conferva* (Diatoma vulgare), ×200.

Diatoms belong to the Confervoid Algæ, but are remarkable in consisting of an extremely brittle structure composed of silex. They are found in nearly all places where there is water, either growing on other plants, or forming a dense mass at the bottom. Their colour, being generally of a yellowish brown, makes them very distinguishable when occurring at the bottom of ponds &c. The species are very numerous, and they form an order of plants that have been much studied—perhaps a little too much so, to the exclusion of other minute and remarkable forms of vegetable and animal life.

If they are to be preserved in their natural state, they are best mounted in a shallow cell in fluid; but the siliceous valves or frustules are generally cleaned by boiling in nitric acid for a short time, and the species separated by taking advantage of their different specific gravities. They may then be mounted dry or in Canada balsam as usual.

Fig. 57.—A Species of Unicellular Alga (Volvox globator).
× 40.

It is only within the last few years that this microscopic organism has been thoroughly examined and found to be one of the Unicellular Algæ, before which time it was thought to be an infusorial animalcule. On the examination of fresh specimens, which may often be procured in ponds, or quiet brooks, ditches, &c., that which appear to the naked eye as minute globular bodies moving with a rolling motion under a low power, say, 1 inch, the cause of motion will be seen to consist in a multitude of minute hairs or cilia, as they are usually, with which the surface of the sphere is covered; these act as oars. In the interior a number of small green spheres will be seen; these are the young colonies and, on the rupture of the membrane of the parent, they escape, grow, and increase. They are preserved with difficulty so as to show the cilia. They appear to keep tolerably well when mounted in a shallow cell in weak alcohol and water.

Fig. 58.—A Diatom in its Natural State on a Seaweed
(Diatoma vulgare), × 200.

Diatoms belong to the Unicellular Algæ, but are remarkable in consisting of an extremely delicate structure composed of silex. They are found in nearly all places where there is water, either growing on other plants, or forming a dense mass at the bottom. Their colour, being generally of a yellowish brown, makes them very distinguishable when occurring at the bottom of ponds, &c. The species are very numerous, and their forms so beautiful that they have been much studied—perhaps a little too much so, to the exclusion of other subjects equally interesting in forms of vegetable and animal life.

If they are to be preserved in their natural state, they are best mounted in a shallow cell in fluid; but the siliceous valves of frustules are generally obtained by boiling in nitric acid for a short time, and the species separated by taking advantage of their different specific gravities. They may then be mounted dry or in Canada balsam as usual.

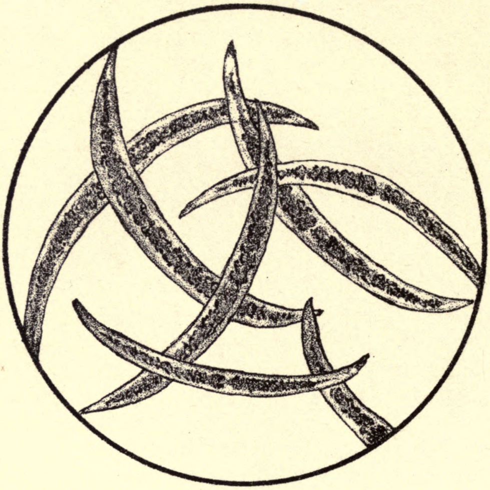

Fig. 99.

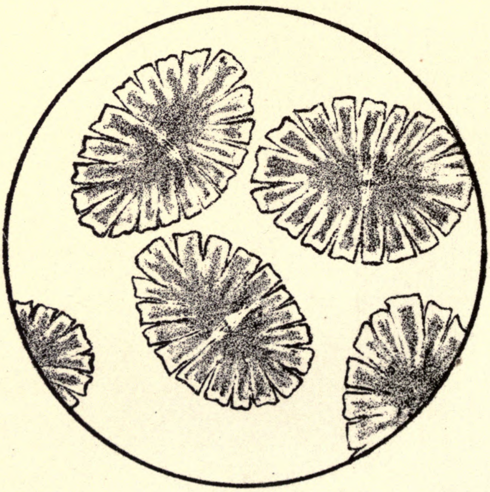

Fig. 100.

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Fig. 99.—*A Species of Desmid* (Closterium Leibleinii), × 120.

Desmids also belong to the Confervoid Algæ; they may usually be distinguished from Diatoms, in their natural state, by their green colour. They, as well as Diatoms, occur in large numbers in ponds that have an exposed situation, although they may be found in nearly all standing water. The great variety and beauty of their forms have caused them to be much studied.

The frustules consist of a cellulose coat or membrane, enclosing the cell-contents. Each frustule forms only a single cell, which may be demonstrated by fracturing one end, when all the cell-contents will escape from the frustule, which of course would not be the case if the apparent division in each frustule were real (see fig. 100). These plants, like the Diatoms, may often be separated from the extraneous matter by the action of light, they always being found to travel towards the lightest part of their habitations.

They may be mounted in a shallow cell, in camphor-water—although it is difficult, if not impossible, to preserve them with their colours &c. uninjured.

Fig. 100.—*A Species of Desmid* (Micrasterias denticulata), × 170.

This, like the preceding species of Desmid, is tolerably common. In the centre of the frustule there will be noticed an apparent transverse division, as mentioned at fig. 99; but the appearance is delusive, as will be seen on examination. That Desmids have the power of locomotion is apparent to all students of microscopy; but how they move is at present a mystery. Their reproduction occurs in three or four ways—by cell-division (which is the commonest mode), by spores, and by ciliated zoospores. The last mode of reproduction is exceedingly interesting; it may often be noticed by examination under the miroscope, more especially in the spring and summer months. The Desmid appears to have its cell-contents contracted, and within this contraction the really active zoospores will be seen in constant motion. The examination of many species will amply repay the trouble; for when this mode of reproduction has been seen, the time and trouble have been well spent.

Fig. 101.

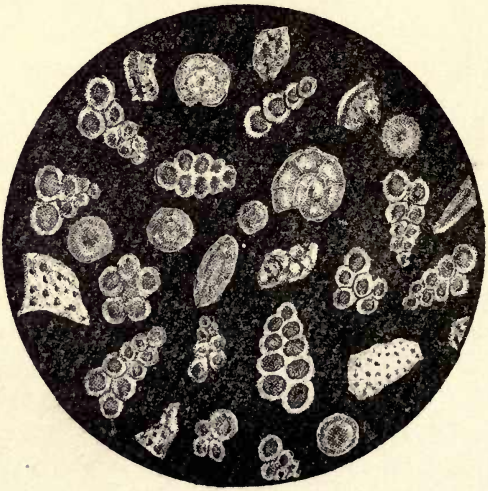

Fig. 102.

Jno. H. Martin, ad nat. del.

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Fig. 101.—*An Infusorial Animalcule* (Amœba diffluens), × 200.

The best description of the *Amœba* would be, "a simple mass of organic animal matter;" for in fact, as to shape, it cannot be described, being constantly changing. By old authors it was well called "*Proteus.*" It may be found in nearly all water that has a quantity of decaying matter, such as leaves, in it; but the best, and a certain place in which to find it, is in the slimy and frothy scum which appears on many ponds in the spring and summer. The form of the animal when it is at rest, which is rarely the case, is globular. It may be considered one of the lowest forms of animal life.

It may be mounted; but objects like this are always best seen when alive. They, together with many other kinds of animalcules, may be kept in suitable glass jars.

Fig. 102.—*Foraminifera from Chalk,* × 100.

This chalk, taken from Detling, near Maidstone, is tolerably rich in fossil Foraminifera (Rotalinæ, Textulariæ, Globigerinæ, &c.) intermixed with a large number of the remarkable disk-like bodies called crystalloids.

A deposit, nearly like chalk in its constituents, is now being deposited in the bed of the Atlantic. The method of preparation is, to take a small piece of chalk and scrape it fine, or, what is better, a small quantity of the natural powder found at the base of the chalk-cliffs; put this into a 6- or 8-ounce phial and fill with water; keep on adding fresh water as long as it comes away of a milky tint; the deposit will then be found to consist of minute shells &c. The waste water is best removed with a glass siphon. To mount the Foraminifera, a small quantity should be soaked in turpentine for a short time, and then mounted in balsam as usual. If any air-bubbles occur, they will disappear in the course of a few days.

Fig. 103.

Fig. 104.

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Fig. 103.—*Foraminifera from the Adriatic Sea,* × 40.

The Foraminifera in this drawing are much smaller than those taken from the Levant end of the Mediterranean Sea, which may possibly be accounted for by the action of the storms in that region; for if the shells were larger no doubt they would be deposited in greater abundance. The Foraminifera are thought by many authors to belong to a family of which the *Amœba* (fig. 101) may be taken as an example. The soft body of the Foraminifera may be separated from its shell by the action of dilute muriatic acid—say, one drop of acid to a teaspoonful of water.

The best way of separating the shells from the surrounding sand &c. is to float them in water, when the sand sinks and the shells are left on the surface.

They may then be mounted in the way recommended under fig. 102; or they may be put up in a dry opaque cell.

Fig. 104.—*Foraminifera from the Levant,* × 20.

These species of Foraminifera are much larger than those in fig. 103, which may possibly be accounted for as remarked in the preceding description. In the shells of the Foraminifera, Polycystina, &c. numerous small holes will be noticed; it is from these holes that the family has been named (Latin, *foramen,* a hole). The holes will be especially noticed in the shells of the Polycystina represented in fig. 105, and in all the common species of the Foraminifera of the chalk formation &c.

Many forms of the recent Foraminifera may be obtained from dredgings at most of our sea-coast towns; but the more beautiful forms are generally obtained from deeper water than is found in our English Channel.

Fig. 105.

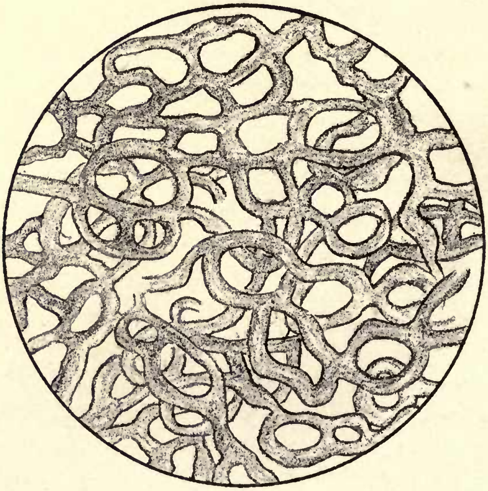

Fig. 106.

Jno. H. Martin. ad nat. del. Dickinson,

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Fig. 105.—*Polycystina: Fossil Shells from Barbadoes,* × 100.

These beautiful shells are closely related in their classification to the Foraminifera, being grouped with them under the head of Rhizopoda, which may be described as consisting of organic structureless bodies, as in *Amœba.* But in the Foraminifera, Polycystina, &c. these bodies are confined in a certain degree within their shell, although they send out, through the small holes in the shells, retractile processes, which answer in their functions to the legs of insects &c., being organs of locomotion. The species are mostly fossil, and are chiefly found in the West-Indian Islands &c. The remarkable beauties of these forms might well be taken advantage of, as patterns for jewellery and other manufactured articles. They, like the Foraminifera, may be mounted in balsam, or in a dry opaque cell &c. However they be mounted, they will well repay the trouble bestowed on them.

Fig. 106.—*Section of Sponge* (Spongia usitatissima), × 120.

On examining this drawing of the horny fibres of the Common Sponge, the reason of their retaining so much water will be evident. The fibres will be noticed to be of a very elastic structure, which, by compression, discharge the water, and on their reflex action absorb it. By the capillary action of the numerous fibres they also retain the water until the sponge is pressed. Sponges, in their living state, are covered with an amorphous jelly-like substance similar to that of the *Amœba* (fig. 101); and if this substance be examined under the microscope, its motions will be found nearly identical. Sponges are mostly marine animals; but there are a few freshwater species to be found in England.

No doubt sponges live by absorbing their prey, in the same manner as the *Amœba.* Sections are best mounted in fluid.

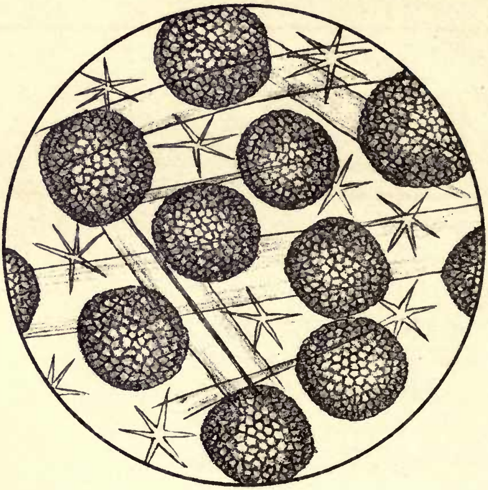

Fig. 107.

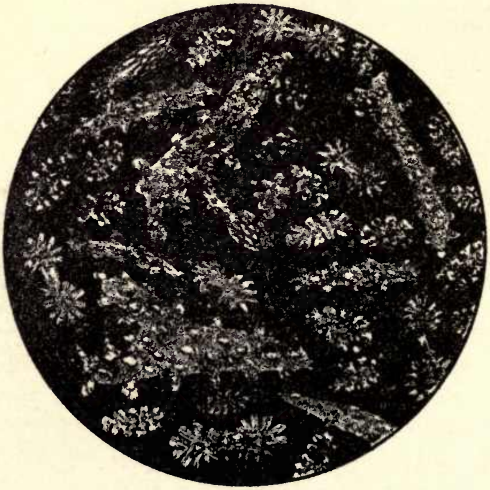

Fig. 108.

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Fig. 107.—*Spicula and Gemmules of Sponge* (Geodia Barreta), $\times 200$.

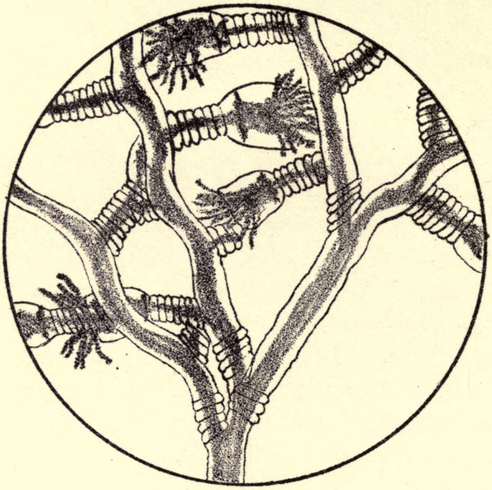
Most sponges contain siliceous bodies called spicula (see drawing). They are of various forms; but the most general are acicular or needle-shaped, and stellate or star-shaped. Most of the siliceous sponges also contain reproductive bodies called gemmules; they are the round masses in the drawing.

Sponges also increase by ordinary ova, as in the case of other animals. To separate the spicula, gemmules, &c. of the siliceous sponges from the surrounding extraneous mass, they must be boiled for a short time in nitric or sulphuric acid and well washed in warm and cold water, then dried, soaked in turpentine, and mounted in Canada balsam, as usual; or they may be mounted dry.

Fig. 108.—*Spicula of* Gorgoniæ: *mixed Species,* $\times 100$.

The spicula of the *Gorgoniæ,* or, as they are popularly called, Sea-fans, are beautiful objects when seen under the parabolic reflector, from which this drawing is taken. The spicula are found imbedded in the body of the animal. There are many species, three or four of which are British.

The method of preparation is to boil the animal, or a portion of it, in diluted potassa fusa until the mass breaks up by the action of the fluid on the horny matter, when the deposit may be removed and re-boiled for a short time in some fresh potassa; then well wash in warm and cold water, dry, soak in turpentine, and mount in balsam. They may also be mounted in a dry opaque cell.



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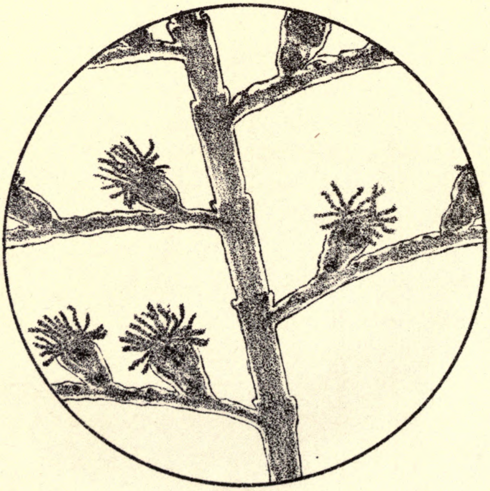

Fig. 110.

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Fig. 109.—*A Zoophyte* (Laomedea gelatinosa), $\times 20$.

This is one of our commonest Zoophytes, the specimen from which the drawing was made having been collected at Hastings. The zoophyte is found at low tide in the rock-pools opposite Eversfield Place, and at many other places along the seaside. The animal will be distinguished by its plumose appearance when growing on the marine Algæ, or on stones, which form its favourite habitat. The description of the species is, "Polypidom rooted, erect, jointed at regular intervals; joints ringed; cells alternate, on short peduncles, campanulate; vesicles axillary, &c." The zoophyte is best when killed immediately by immersion in alcohol, and then mounted in alcohol and water, or in camphor-water.

Fig. 110.—*A Zoophyte* (Plumularia setacea), $\times 20$.

This Zoophyte, like the preceding species, is commonly found on our coasts, more especially the south and south-east coasts. It will often be found growing in great abundance, even more so than the last species, on the underside of rocks &c., and is nearly always found near, if not growing with, *Laomedea gelatinosa.* The description of the animal is, "Stem a single tube, pinnate; pinnæ alternate, one at each joint; cells very remote, campanulate; vesicles elliptical." The animal may be killed by immersion in alcohol, as mentioned with respect to *Laomedea.* It may also be mounted in the same manner.

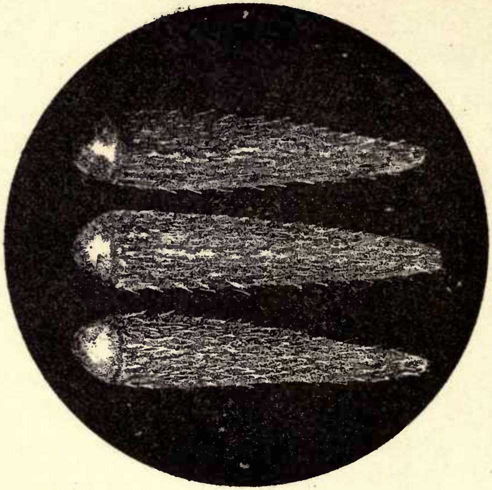

Fig. 111.

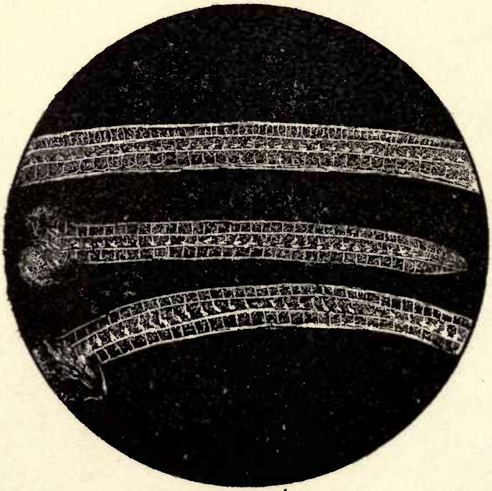

Fig. 112.

Jno H. Martin, ad. nat. del. Dickinson I

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Fig. 111.—*Spines of a Starfish* (Ophiocoma rosula), × 20.

Skeletons of any of our Starfishes may be prepared in the same manner as the spines of this species have been treated—that is, by soaking in very dilute potassa fusa until the bony structure is cleaned; but if the fluid is made too strong, the skeleton separates and becomes useless. If the spines only are wanted, the alkali may be used much stronger. Although common, even the ordinary Starfish (*Asterias rubens*) is worthy of microscopical examination. Mixed with the spines are a number of peculiarly shaped bodies called pedicellariæ. These are supposed to be the organs of locomotion.

The spines, pedicellariæ, &c. are generally best mounted dry.

Fig. 112.—*Spines of* Spatangus, × 20.

These spines, drawn as seen under the parabolic reflector, are taken from the *Spatangus,* a genus of Echinidæ, belonging to the Class Echinodermata, which comprises the Starfishes &c. They show best when mounted in balsam and seen under a low power, although they may be mounted in a dry opaque cell and viewed under condensed reflected light.

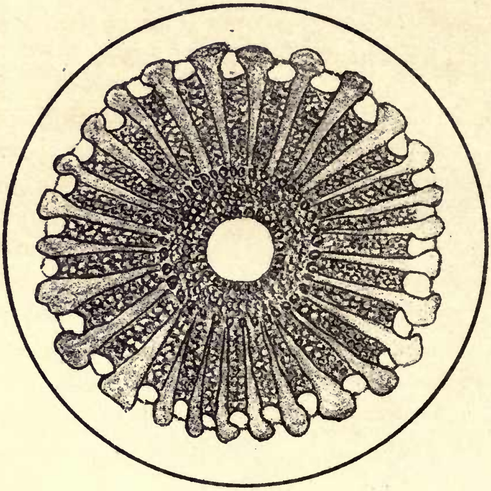

Fig. 113.

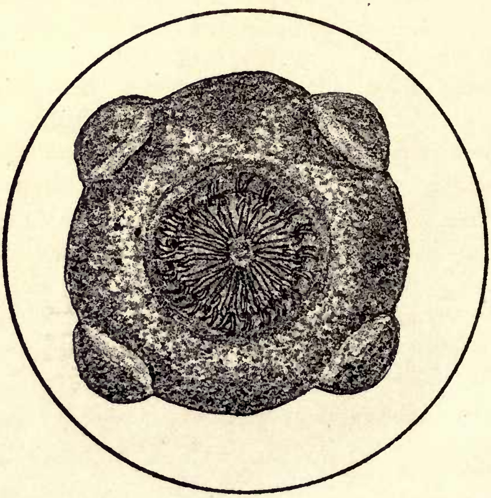

Fig. 114.

Jno. H. Martin, ad. nat. del.

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Fig. 113.—*Transverse Section of an Echinus-spine* (Echinothrix petersii), × 40.

The genus *Echinus,* from which the class Echinodermata derives its name, has many structural beauties, both superficial and otherwise. The spines in nearly all the species furnish most beautiful objects when cut in a transverse manner with a fine saw, then ground exceedingly thin with a file, and finished on a stone. If they are wanted for the polariscope, the grinding may be coarser, and they may then be mounted in balsam. The pedicellariæ, sections of the shell, &c. also make fine objects.

The internal structures of these animals are not less interesting.

Fig. 114.—Entozoon. *Head of a Parasite from the Rabbit* (Cysticercus pisiformis), × 30.

The parasite from which the drawing has been made chiefly inhabits the alimentary canal—but is sometimes met with in other parts, as in the liver, where it has been found in the cyst state. Another of the species (*Cysticercus tenuicollis*) is occasionally met with in the human body. The parasite is something of the shape of a bird's egg, with a neck which may be elongated at pleasure; the four projections in the drawing are the sucking-disks. This species may be taken as an example of the internal parasites called Entozoa.

Most of the species show best when mounted in balsam after due preparation.

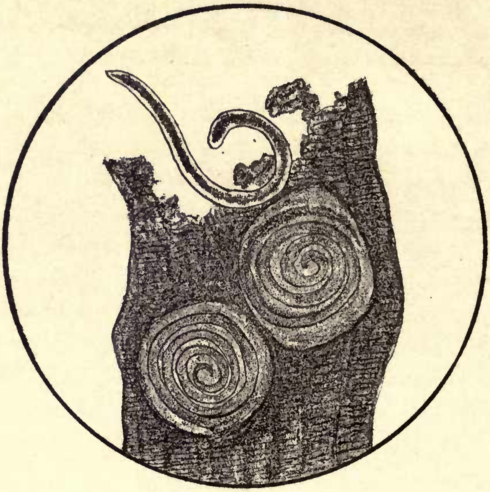

Fig. 115.

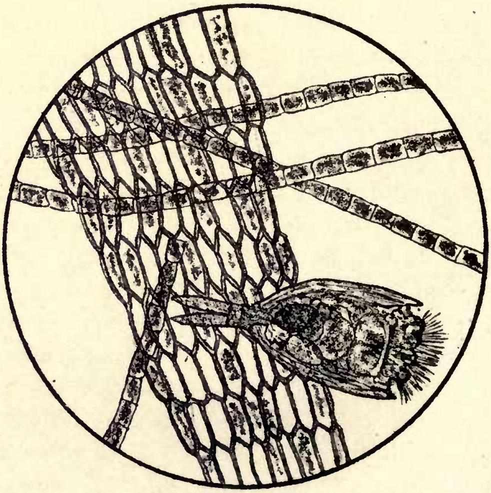

Fig. 116.

Jno H. Martin, ad nat. del.

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Fig. 115.—Entozoon. Trichina spiralis, *from Human Muscle,* × 50.

This Entozoon is particularly interesting, from the fact that its presence in large numbers in pork renders the meat diseased, and has produced in those who ate it an epidemic called trichinosis.

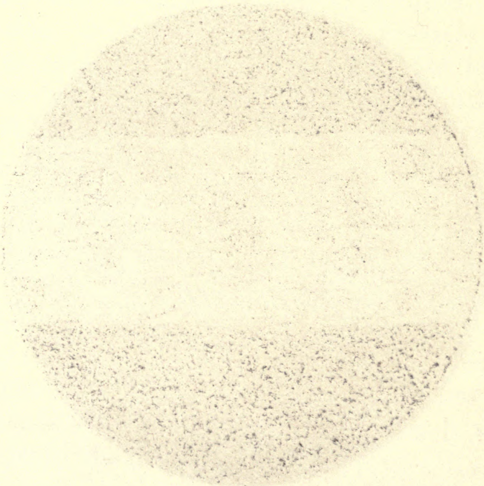
On the examination of the muscle in which the parasite has taken up its abode, small specks will be seen (even with the naked eye); and on placing the part under a moderate power of the microscope, the worm will be seen coiled up in its oval or circular orange-coloured cyst. The worms on issuing from this cyst follow the course of the voluntary muscles. Some of the worms die; but even those that are left often number 50,000 to a single ounce of flesh.

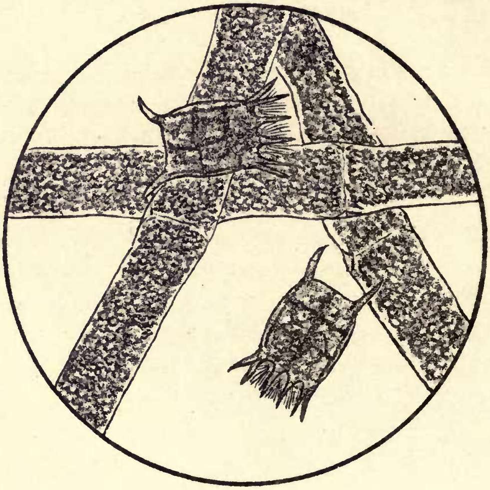
The parasite is best when mounted in balsam.

Fig. 116.—*A Wheel-animalcule* (Squamella oblonga), × 100.

The Rotatoria, or Wheel-animalcules, form a very interesting class to all students of nature. Their chief characteristics are rotatory or wheel-like organs, from which the genus Rotifera and class Rotatoria derive their names. Tail-like processes are present in most of the species, similar in shape to the same appendage in the *Cyclops* (see fig. 119); and a gizzard just below the mouth is to be seen in constant motion, grinding &c., in nearly all the larger species. The other parts of the alimentary canal, such as the stomach &c., are short. The Rotatoria are found nearly everywhere where the water is not putrid; they are very tenacious of life. The most common species is *Rotifer vulgaris*; this species shows the ciliated wheels well. The Rotatoria are best seen when examined in their natural state; the above drawing is taken directly from the living animal.

They may be mounted in alcohol and water if great care is taken; but they are difficult to keep well.





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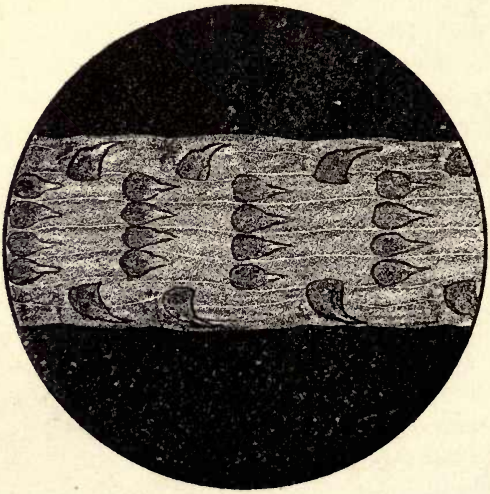

Fig. 118.

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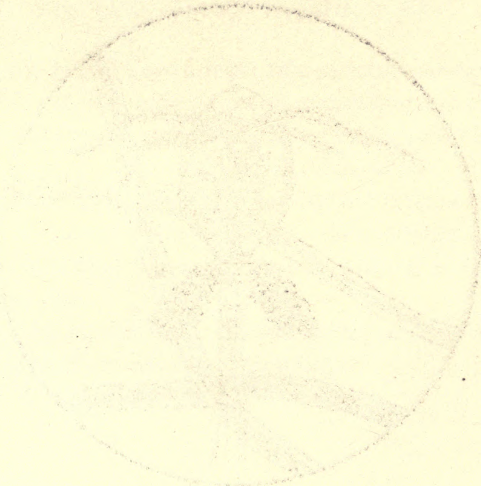
Fig. 117.—*A Wheel-animalcule* (Noteus quadricornis), × 100.

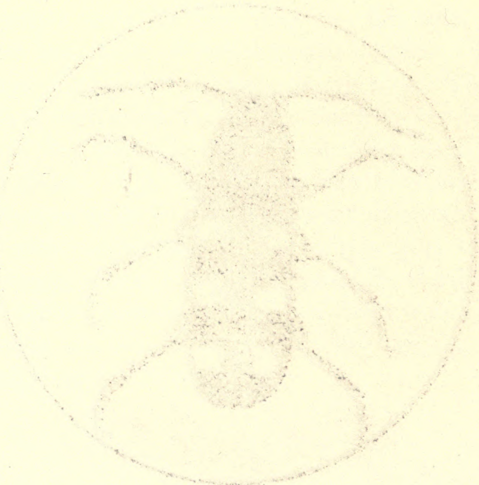
This animalcule I found in large quantities in a large glass jar that I use for the propagation of various species of minute animal life. The description of the species is as follows:—"Carapace suborbicular, depressed, scabrous, areolate, with four spines in front and two behind." This, like the preceding drawing, has been taken from the living animal. It is still more difficult to mount, being rather smaller, than *Squamella oblonga*; but it is quite possible to make some good mounts if a dozen or more can be put in the same cell.

They are best mounted in alcohol and water.

Fig. 118.—*Palate of Limpet* (Patella vulgata), × 40.

The palates of the Mollusca form a large series of beautiful and interesting objects, of which the drawing may be taken as a type. They may be easily examined in the whelk, periwinkle, snail, slug, the water-snails, such as *Limnæus, Planorbis*, &c. The tongues are long ribbon-like bodies, having on their surface beautiful horny (chitine) teeth, which are placed upon them in various patterns, according to the species. From the examination of the tongue, the family &c. may often be determined. The tongue or palate is generally found coiled up at the back of the head; but this is not a constant characteristic, as it is often found elsewhere in many of the species. After taking it out, it must be boiled some time in diluted potassa fusa, then well washed in warm water, and dried under pressure; and if wanted for the polariscope or parabolic reflector, it must be soaked in turpentine and mounted in balsam as usual. The above drawing is made from it as seen under the parabolic reflector.





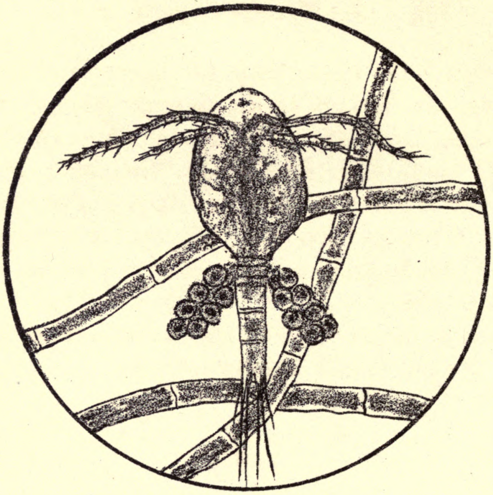


Fig. 119.

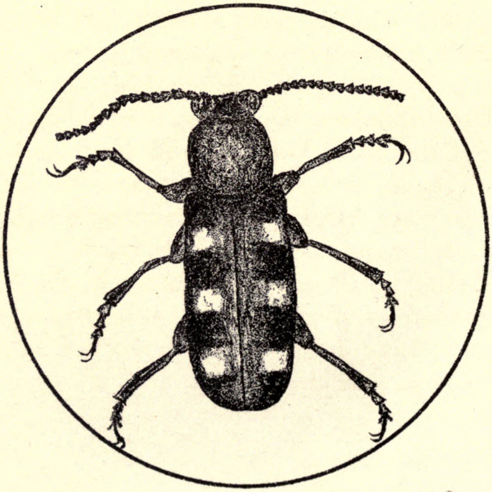


Fig. 120.

Jno. H. Martin, ad. nat. del. Dickinson.

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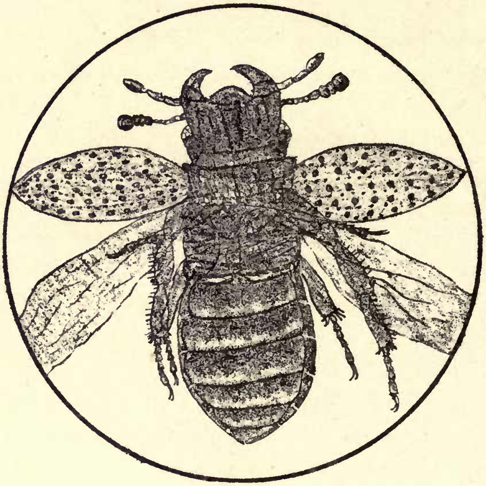
Fig. 119.—*Cyclops vulgaris,* × 40.

This animal is also drawn from life, as seen amongst a mass of Conferva. It belongs to the Entomostraca, a division of the large class Crustacea. The characteristics of the species are:—"Foot-jaws large and strong, branched; eye single, frontal; inferior antennæ simple; external ovaries two." It is variable in colour. They are extremely common, so that scarcely any standing water can be seen without them. They vary much in size.

They may be mounted in diluted acetic acid, or in alcohol and water (a shallow cell must be used).

Fig. 120.—*Asparagus-Beetle* (Crioceris asparagi), Order Coleoptera, × 6.

This, together with the next drawing, has been taken to illustrate the large order of Coleoptera or Beetles. The larvæ of this genus (*Crioceris*) are very destructive. The British species, which represents the genus, lives on the asparagus. The colour of the insect is tawny, with large black bands or bars on the elytra. This species, together with many of our beetles, is too horny to be mounted in a transparent manner, as is usual with many insects. The only way is to kill the insect in boiling water, and immediately fix the legs &c. in position, on white gummed paper, then cover with a cell, and, after the beetle has become thoroughly dry and set, seal it as nearly air-tight as possible.



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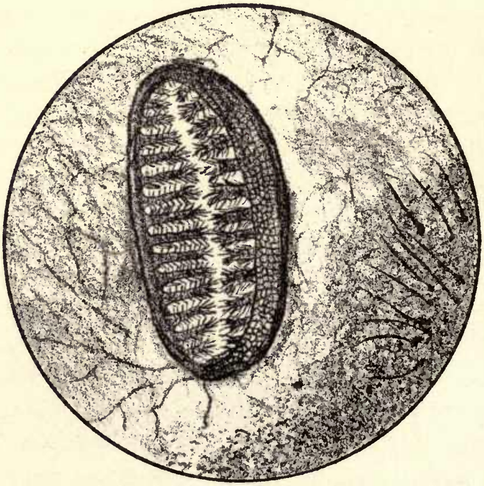

Fig. 122.

Jno. H. Martin. ad nat. del.

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Fig. 121.—*Water-weed Beetle* (Helophorus granularis), × 12.

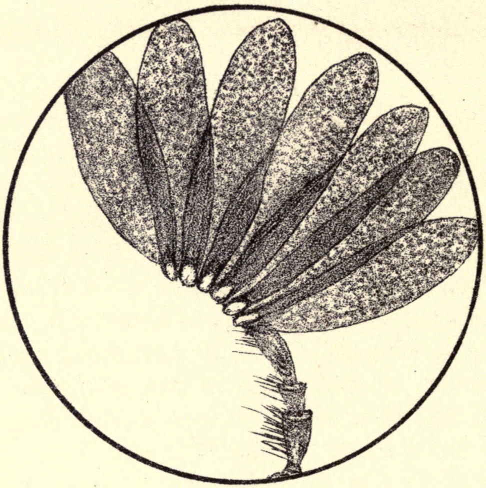
This little beetle may often be noticed darting about amongst the weeds in ponds, and may also often be found in the standing water of old water-butts, more especially if the butt has been left in an exposed and sunny spot. The following is a description of the order Coleoptera :—" Wings four; anterior (elytra) hard, coriaceous, or horny, covering the posterior, which are membranous and transversely folded; mouth formed for manducation, furnished with mandibles, maxillæ, and palpi: metamorphosis complete."

This beetle may be mounted in a transparent manner. Soak the insect in a moderately strong solution of potassa fusa until it is transparent, then well wash in warm water, and dry under pressure between glass slips; soak in pure turpentine, and mount in balsam as usual.

Fig. 122.—*Spiracle of Great Water-Beetle* (Dytiscus marginalis), × 40.

Spiracles are the breathing-pores of insects, of which this drawing is an example. They supply them with the air necessary for the purification of the blood, which in the case of most animals passes through the mouth, but in insects it is carried through tubes called tracheæ, which are joined to the spiracles. The spiracles of the various orders of insects differ but slightly in their general form, being principally oval or circular; at their orifices hairs are generally placed to prevent foreign substances, such as dust &c., from entering into the minute ramifications of the tracheæ. Spiracles are mostly found on the abdomen, and also on the thorax of insects; in the Greater Water-Beetle they are found under the wings.

The mode of preparation is to soak the skin containing the spiracle for a short time in diluted potassa fusa, wash in warm water, dry under pressure, soak in turpentine, and mount in Canada balsam.



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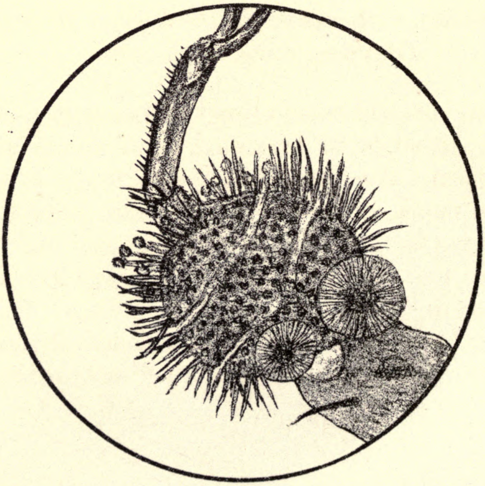

Fig. 124.

Jno. H. Martin ad. nat. del.

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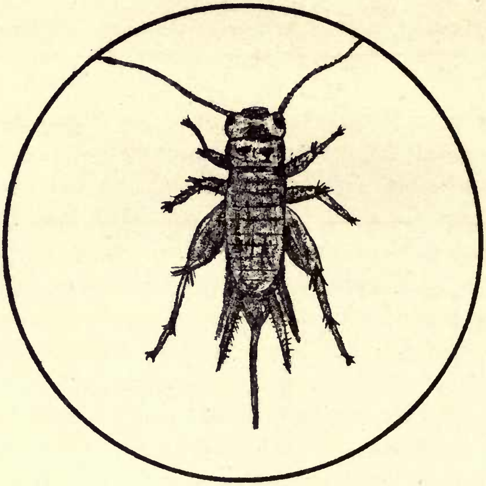
Fig. 123.—*Antenna of Cockchafer* (Melolontha vulgaris), $\times 8$.

The antennæ of insects vary much as to shape, although the general form is setaceous—that is, having the joints gradually diminishing in size from the part that joins the head to the apex. Another form is the lamellate, so called from a number of lamellæ or plates joined at their bases; this form of antennæ is chiefly found in the division Lamellicornes of the order Coleoptera, or Beetles, of which the Cockchafer is an example. Most of the antennæ require but little preparation; to soak them in pure turpentine for two or three days and then mount in balsam is all they require if tolerably transparent. When thickened they must be rendered transparent by the action of the diluted potassa.

Fig. 124.—*Leg, with suckers, of the Greater Water-Beetle* (Dytiscus marginalis), $\times 8$.

The remarkable expansion of part of the leg of this Water-Beetle into a shield, or, as it is called, a patella, will be noticed in the drawing. This peculiarity is only found in the male insect. The tarsus, or foot, is covered with minute suckers or disks, convex in their structure, and often seated on short stalks; there are also generally to be found two or more larger suckers or disks.

This object may be mounted in an opaque cell; or it may be treated with potassa, washed, dried, and mounted in balsam as usual.



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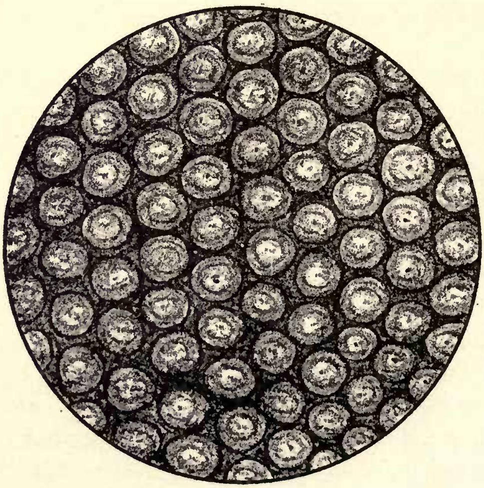

Fig. 126.

Jno. H. Martin, ad nat del   Dickinson. In

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Fig. 125.—*House-Cricket* (Acheta domestica), natural size. Order Orthoptera.

The order Orthoptera contains some of the most interesting insects in regard to their structural characteristics. Among the most remarkable may be mentioned the Mantis, Cockroaches, Earwigs, Locusts, Crickets, &c. The description of the general structure of this order is as follows:—"Wings four, the upper coriaceous, veiny; the inferior membranous, longitudinally plaited like a fan; mouth serving for manducation, with strong mandibles; maxillæ furnished with a cylindrical helmet: metamorphosis incomplete."

The House-Cricket is one of the best insects for an amateur to dissect, as the organs are tolerably large, and at the same time interesting. Small specimens may be mounted in balsam after the usual treatment for insects.

Fig. 126.—*Eye of Locust* (Acrydium migratorium), × 80.

The eyes of insects vary much in size, and also in the number of facets composing a single eye. Some of the largest are to be found in the Libellulæ (Dragonflies); but, from the size of the facets, the eye of the Locust may be considered one of the first. Insects see differently from us, as each of the facets answers to the single eye of a higher animal; therefore the objects are reflected to them in much larger numbers, and no doubt this acute impression that their brain receives causes that extreme quickness of sight for which most insects are remarkable (see the various insect-eyes). Many of the eyes are best mounted dry, after being well washed, &c.; others are best when mounted in fluid; and scarcely any show well in balsam, as it makes them too transparent.

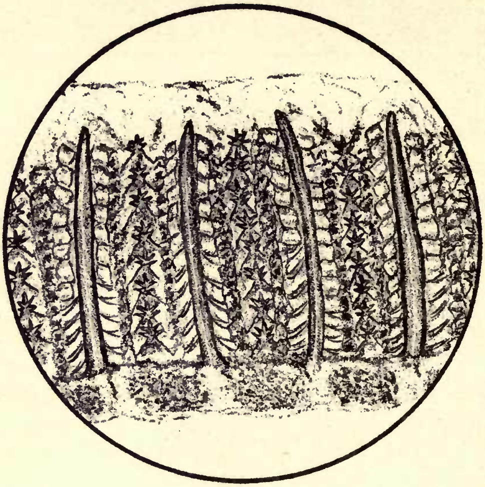

Fig. 127.

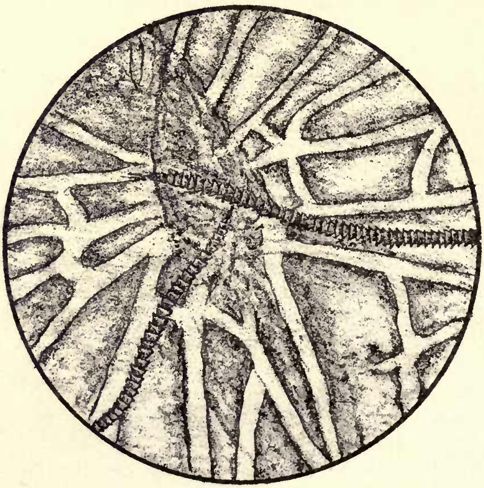

Fig. 128.

Jno. H. Martin, ad nat del. Dickinso

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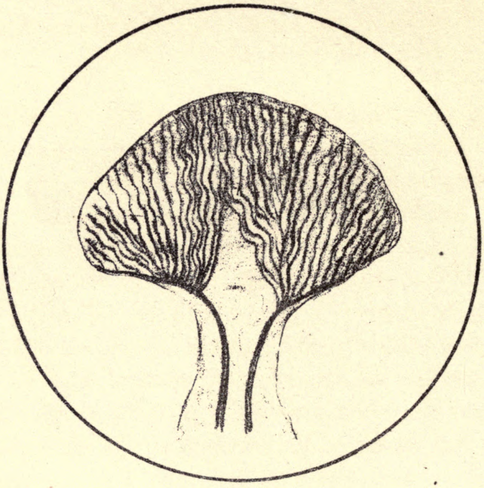
Fig. 127.—*Gizzard of House-Cricket* (Acheta domestica), × 20.

The variety of gizzards and gastric teeth to be found in insects, more especially in the orders Orthoptera and Coleoptera, is to a certain extent unlimited; a field is open here for wide research, especially in foreign insects. The beauty of these structures will always make them attractive objects to microscopists. The dissection of a gizzard taken from the House-Cricket will lead the way for further inquiry and research.

The mode of preparation is to separate the gizzard from the alimentary canal, cut it open with a fine pair of scissors, boil it in a weak solution of potassa fusa until clean, wash in warm water, and mount in a cell containing acetic acid.

Fig. 128.—*Noise-apparatus of House-Cricket* (Acheta domestica), × 20.

The well-known song of the Cricket perhaps requires a slight explanation. The upper coriaceous wings of this insect possess near their inner margin a short, horny, and rasp-like apparatus, one to each wing. By the rapid motion given to the wings by the strong voluntary muscles, on the rasp-like bodies touching each other they produce a sound not unlike the chirping of some young birds; the sound is also greatly assisted by the membranous substance stretched over the surface of the wings. The drawing represents the rasp-like bodies in the act of producing the sound. The wings must be well washed, dried under pressure, soaked in turpentine, and mounted in balsam.



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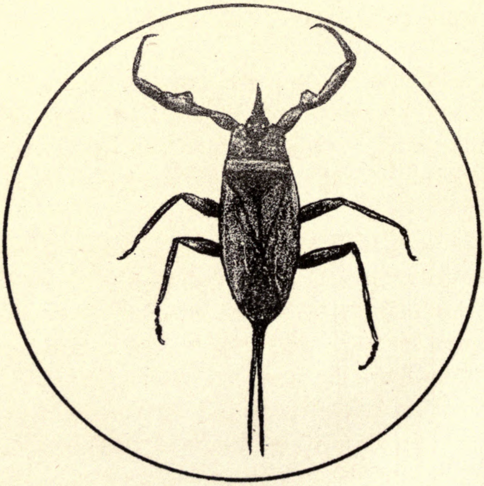

Fig. 130.

Jno. H. Martin, ad nat. del.

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Fig. 129.—*Tongue of the House-Cricket* (Acheta domestica), × 15.

The tongues of the various insects differ according to the work that they have to perform, as may be seen by examining the descriptions and figures of the various tongues. The common House-Cricket, living chiefly on suction, has a tongue that is well adapted to the purpose, being composed of a quantity of minute tubes, which all join at last into two large ones, which conduct the juices into the alimentary canal. The Crickets are also furnished with strong mandibles.

The tongue may be dried under pressure, and mounted in balsam; or it may be mounted in a shallow cell with acetic acid. The last mode of preparation shows the tubes of the tongue best.

Fig. 130.—*Water-Scorpion* (Nepa cinerea), natural size. Order Hemiptera, Division Heteroptera.

The insects of this division of the order are chiefly remarkable for having the elytra half membranous and half coriaceous. The beak also projects from the upper part of the head (see drawing); and this beak is characteristic of the order.

The insect is tolerably common in most ponds. The appendage at the extremity of the insect is used for the inspiration of air, and, no doubt, also as an ovipositor. The name Water-Scorpion has been well applied; for its rapacity is very great, as may be found by personal observation.

The insect, though very thick and coriaceous, may, by long maceration in the potassa, be rendered sufficiently soft and pliable to be pressed between two slips of glass, then well washed, dried under pressure, soaked in turpentine, and mounted in balsam as usual.

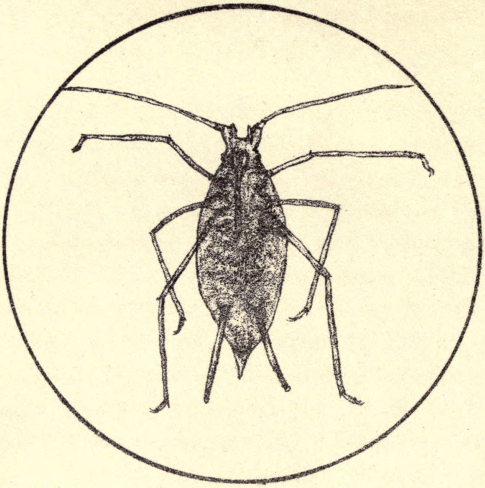

Fig. 131.

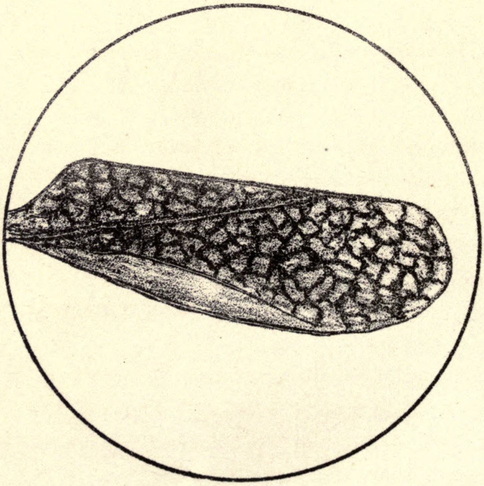

Fig. 132.

Jno. H. Martin, ad. nat. del. Dickinso

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Fig. 131.—*Hop-Aphis* (Aphis humuli), × 20. Order Hemiptera, Division Homoptera.

The insects of this division of the order Hemiptera are chiefly distinguished by having their beak growing from the lower part of the head—also by not having the elytra half coriaceous and half membranous as in the Heteroptera, but all of membranous consistency. The Hop-Aphis is one of the most troublesome insects to farmers; and if it were not for the larva of the *Coccinella* and other insects living entirely upon them, they would be more so. The sweet fluid which these insects secrete, called honey-dew, is much liked by ants; this fluid exudes from the two tube-like processes called "paps," situated at the back. On the ants pressing these "paps" gently, they are able to procure this fluid, of which they are extremely fond. These insects are best mounted in acetic acid, in a shallow cell, sealed with liquid india-rubber or dissolved gutta percha.

Fig. 132.—*Wing-case (Elytron) of Water-boatman* (Notonecta glauca), × 5.

The elytron of this insect has been taken to illustrate the partially membranous and coriaceous elytra of the division Heteroptera of the order Hemiptera, as mentioned at fig. 130. On referring to the drawing, the membranous may be distinguished from the coriaceous or leathery parts, the membranous being nearly transparent, and the coriaceous having a more opaque appearance.

This, together with most of the transparent elytra of the various insects, requires scarcely any preparation, simply soaking in hot water, and drying under strong pressure, then placing it in turpentine for a few minutes, and mounting in balsam.

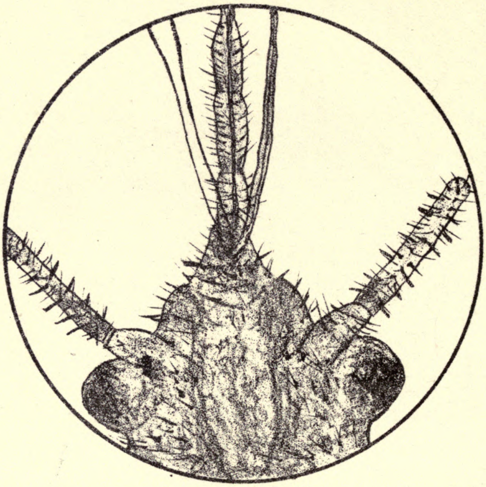

Fig. 133.

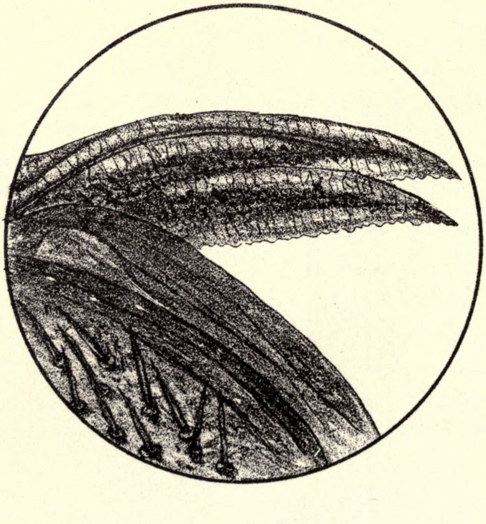

Fig. 134.

Jno H. Martin, ad: nat. del. Dickinso

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Fig. 133.—*Rostrum and Lancets of the Bug* (Cimex lectularius), × 40.

This is another example of the beak for which the order is noted; only, in this case, it is furnished with lancets. These lancets are about $\frac{1}{20}$ less than the lancets of the Flea (see fig. 162). These insects seem to draw the blood, not by suction, as the Leech, but by moving the three thread-like setæ or lancets against each other; this causes the blood to flow up the rostrum or beak with a kind of capillary motion. The eggs of this Bug make a good object where mounted opaque.

To mount the insect it must be soaked in diluted potassa fusa for at least twelve hours, then press out the contents of the body, place it in the potassa for two hours more, well wash in warm water, dry under strong pressure, soak in turpentine, and mount in balsam.

Fig. 134.—*Saws of Froghopper* (Cercopis spumaria), × 40.

Of all our common British insects, perhaps this is one of the least-known. Most persons have seen the frothy appearance on branches and leaves in the early summer months, and also know that it is commonly called Cuckoo-spit; and that is nearly all they know about it. Few persons have examined this little insect with its various natural apparatus for the several functions it has to perform, and without which the species would soon be extinct. The mature insect is furnished with extremely fine saws (see drawing), with which it cuts a slit in generally the last annual shoot, and deposits an egg. The larva, on leaving the egg, immediately covers itself with a froth, in this way: fixing its beak (which organ is characteristic of the order) into the cellular tissue of the plant on which it is situated, it sucks up sufficient of the sap to cover itself, and then pours out a secretion from the organs placed at the end of its body; this secretion is the froth. The insect is thus protected, and passes through its stages, until it arrives at the perfect state. The larva may be mounted in acetic acid, or dried and in balsam. The mature insect is best mounted in balsam.

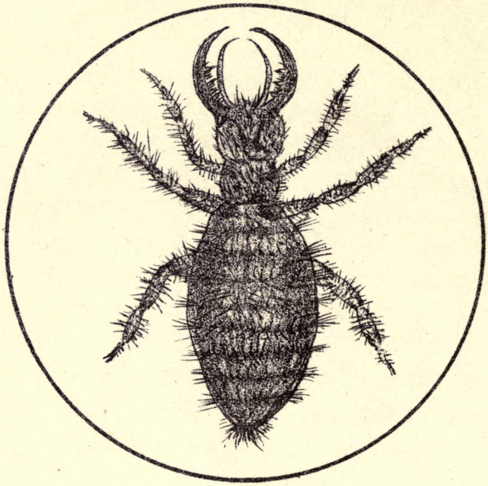

Fig. 135.

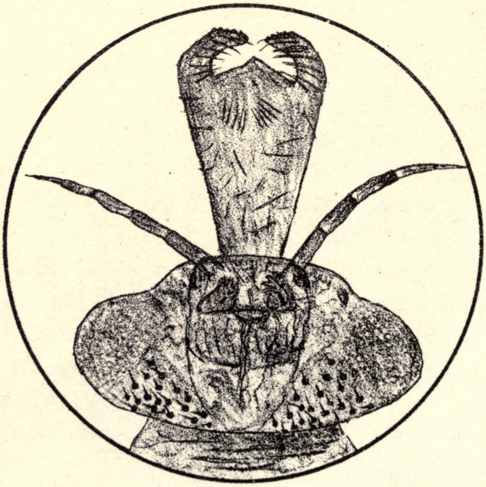

Fig. 136.

Jno. H. Martin, ad. nat. del.

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Fig. 135.—*Larva of the Ant-lion* (Myrmeleon formicarius), ×4. Order Neuroptera.

The chief characteristics of the order are:—that the perfect insects have four large membranous wings, of which the Dragonfly is an example; and that the larvæ are nearly all fnrnished with very strong mandibles, in the case of some of the Dragonflies called the mask (see fig. 136). Most of the larvæ of this order live in water; but the larva of the Ant-lion, with others, forms an exception. With its strong legs and mandibles it makes for itself a funnel of loose sand or soil, at the bottom of which it lies concealed, waiting for its prey. This larva is also furnished with very strong mandibles.

It is best mounted in balsam. The perfect insect very much resembles the small blue Dragonfly (*Agrion puella*) that is so very commonly met with at the margins of our rivers and ponds.

Fig. 136.—*Head of Larva of the Long-bodied Dragonfly* (Agrion virgo), ×12.

The larvæ of the Dragonflies are furnished with a kind of moveable mask, which is armed with very strong pincers. This mask is concealed under the head of the insect, and when called into action it is darted forward to nearly the entire length of the body. After its prey has been caught, it is brought by this peculiar apparatus into the reach of the mouth. The respiration of the larvæ of the Dragonflies is also remarkable; they take in a certain amount of water, and, after the oxygen has been exhausted, discharge the same suddenly (by this mechanism the larva is also propelled in the water).

The larvæ may be mounted in a cell in strong acetic acid, or dried and mounted in balsam.

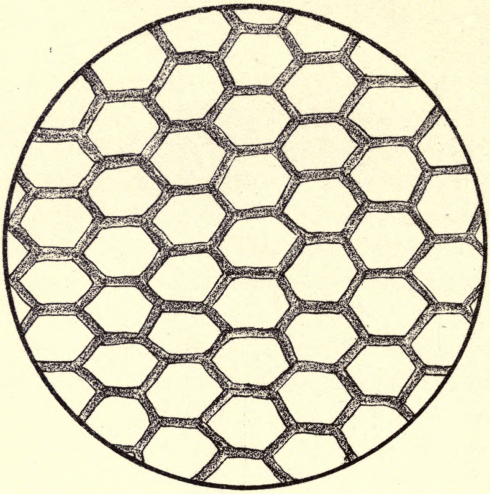

Fig. 137.

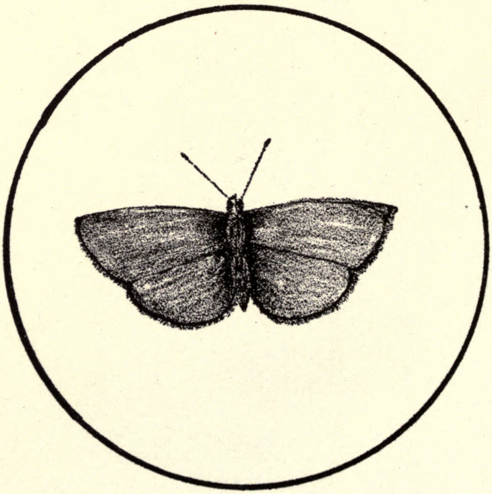

Fig. 138.

Jno. H. Martin. ad. nat. del. Dickinson.

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Fig. 137.—*Eye of Dragonfly* (Libellula depressa), × 200.

The eye of the Dragonfly is well adapted for the work which it has to perform, which is to perceive quickly any insect in its rapid flight through the air. On examining a Dragonfly the eyes will be found to comprise nearly all the head; they are also extremely prominent. The structure of the eye is the same as in other insects (see fig. 126 &c.); but the lenses are rather larger than those of the Diptera, Lepidoptera, &c.

After separating the eye, it must be macerated for a short time in the diluted potassa, well washed, and dried under pressure; it may then be mounted dry, or in a shallow cell with acetic acid, or any other good preservative fluid.

Fig. 138.—*Meadow- blue Butterfly* (Polyommatus Alexis), natural size. Order Lepidoptera.

This Butterfly has been taken to illustrate the order. The chief difference between the Moths and the Butterflies lies in the antennæ of the former terminating in a point, those of the latter in a clavate or club-shaped end. The position of the scales on the wing-membrane is nearly the same in both divisions of the order (see fig. 142). Both Moths and Butterflies furnish a large series of instructive objects. One of the most characteristic structures of the order is the proboscis (see fig. 141). Many of the eggs are also most beautiful objects (see figs. 143, 144). The scales as situated *in situ* on the wings are generally best when mounted in a dry opaque cell.

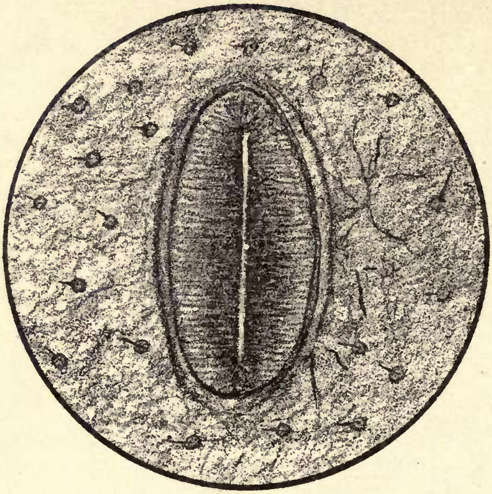

Fig. 139.

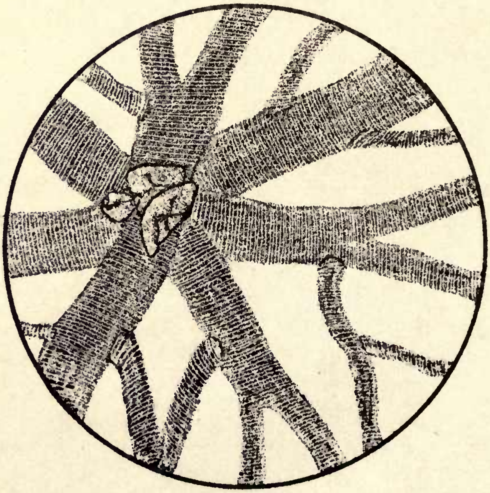

Fig. 140.

Jno. H. Martin. ad nat. del.

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Fig. 139.—*Spiracle of Larva of the Death's-Head Hawk-Moth* (Acherontia atropos), × 20.

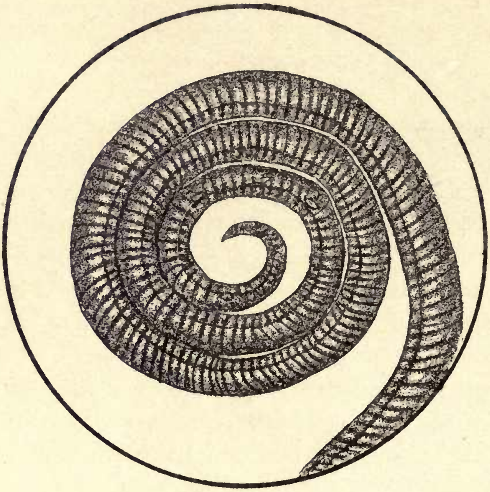
The spiracle of the larva of this moth (which is generally found on the potato-plant) may be taken as the general type of the spiracles of most of the larvæ of the Moths and Butterflies. On dissecting any larva, a number of minute tubes, greatly resembling the spiral vascular tissue of plants (see fig. 16), will be found leading to each spiracle or breathing-pore; these tubes or tracheæ are figured in the following drawing.

The spiracles, when cut away from the side of any larva, must be soaked for a short time in diluted potassa fusa as usual, then well washed, dried under pressure, soaked in turpentine, and mounted in balsam; or they may be mounted in a shallow cell in acetic acid.

Fig. 140.—*Tracheæ of Silkworm* (*the larva of* Bombyx mori), × 40.

Tracheæ of all insects resemble each other in structure, although differing greatly in size. They are best seen when taken from any of the larvæ of the large Moths or Butterflies. They consist of tubes greatly resembling the spiral vascular tissue of plants (see fig. 16), and, like the components of this tissue, they may be uncoiled. These tubes lead to the air-pores, or, as they are called, the spiracles (see figs. 122, 139, 154, &c.) of insects, and serve to conduct the air to all the central parts of the body.

The tracheæ show best when mounted in fluid, although they may be dried and mounted in balsam.



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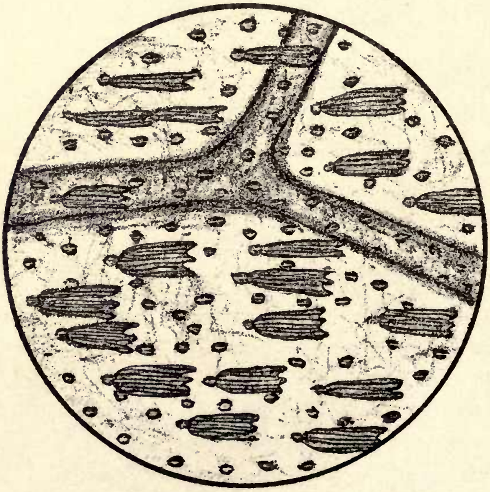

Fig. 142.

Jno. H. Martin, ad nat. del.

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Fig. 141.—*Proboscis of Humming-Bird Hawk-Moth* (Macroglossa stellatarum), × 20.

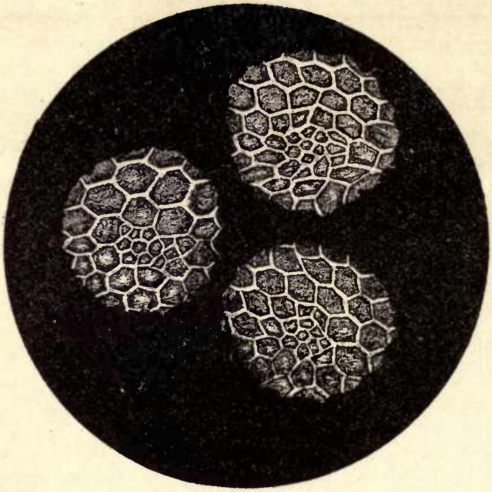
The antlia, or, as it is commonly called, the proboscis, of the Lepidoptera is an organ most beautifully adapted for its purpose, which is to convey the honey of flowers to the mouth of the insect. It is composed of two maxillæ containing a great number of strong muscular bands. These maxillæ when separate are convex on the outer and concave on the inner side; so when they are joined together they form a tube (see drawing); inside this tube are often found a number of tracheæ communicating with the head, and in some species the tip of the proboscis is furnished with a number of papillæ.

The antlia may be mounted in a cell with strong acetic acid; or placed in diluted potassa fusa for two hours, well washed, dried under pressure, and mounted in balsam.

Fig. 142.—*Scales of the Six-spot Burnet-Moth,* in situ (Zygæna filipendulæ), × 100.

All Moths and Butterflies, and a few other insects, are furnished with a large number of minute epidermal bodies called scales; and it is these scales that give the gorgeous colouring to the wings of the various species. The scales vary much in size, shape, and colour; they are inserted into the membrane of the wing by the short stalks which fit into the cups or holes placed in the membrane (see drawing). These flat scales are generally ranged in rows, and overtop each other in the same way as the scales of a fish.

To show the scales well, it is best to mount the wing in an opaque cell; or if wanted to show their attachments *in situ,* the wing must be rubbed and then mounted in a dry transparent cell, which is best made of cardboard.



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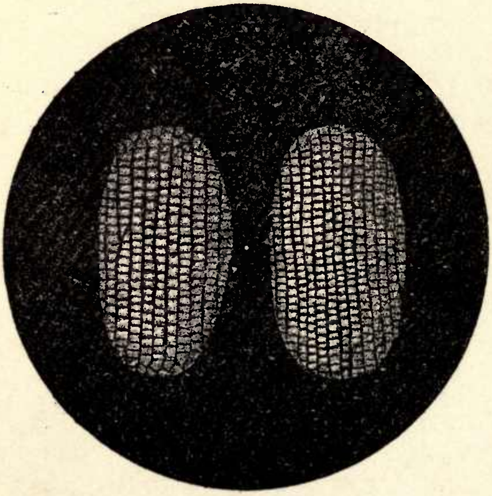

Fig. 144.

Jno. H. Martin, ad nat. del.

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Fig. 143.—*Eggs of small Copper Butterfly* (Chrysophanus Phlæas), ×30.

The eggs of many insects, more especially those belonging to the order Lepidoptera, greatly resemble many of the smaller seeds in their superficial microscopic appearance (see fig. 45). Most of them are very distinctive in their markings, and the exact species may almost always be ascertained from their examination. But there is still a large field for microscopic investigations, as the eggs of many insects have never been examined at all.

They are rather difficult to mount well. The simplest plan is to wait until the small caterpillar emerges from the eggs; or their vitality may be destroyed by the application of a red-hot needle, but care must be taken to only just prick the egg; they may then be mounted in a dry opaque cell.

Fig. 144.—*Eggs of Willow- beauty Moth* (Boarmia rhomboidaria), ×40.

The Moth from which these eggs were taken, is found nearly everywhere, but more especially on plum and birch trees. The eggs of many of the Moths are quite as beautiful as the eggs of the Butterflies; but scarcely any of them have ever been mounted, drawn, or described.

These eggs may be mounted in the same manner as those previously described.

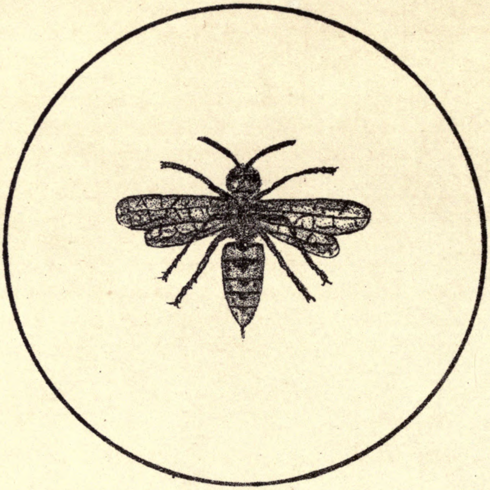

Fig. 145.

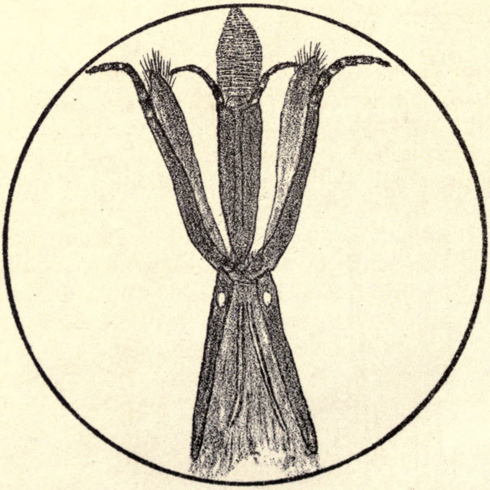

Fig. 146.

Jno. H. Martin. ad. nat. del. Dickinson, Imp.

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Fig. 145.—*The Common Wasp* (Vespa vulgaris), natural size. Order Hymenoptera.

The order Hymenoptera includes most of the architectural (or nest-building) insects, which are also noted for their great intelligence. The chief structural characteristics of the order are:—"Wings four, when at rest lying horizontally upon the body, membranous; posterior ones smaller, and with fewer veins, and generally having a single row of hooks; maxillæ elongate, generally slender, sheathing the labium; mandibles two; abdomen of the females almost always terminated by a borer or a sting: metamorphosis complete." On referring to fig. 147, the row of hooks mentioned in this description will be seen in their natural position, as placed when the wings are united. Bees, Wasps, Ants, Gall-insects, Sawflies, Ichneumons, &c. all belong to this order.

Wasps &c. may be mounted whole after prolonged maceration in tolerably strong solution of potassa fusa, well washing, drying under strong pressure, and then mounting in balsam.

Fig. 146.—*Tongue of Sand-Bee* (Andræna melitta), ×20.

This tongue has been taken to illustrate the general structure of the tongues of the Bees and Wasps. It is as well adapted for suction as the proboscis or tongue of the Blow-Fly (see fig. 151), though of a different form; and it is also supposed to be the chief instrument which the Bee uses in the manufacture of her marvellous hexagonal cells. The Bee having sucked up sufficient honey from the flowers with this organ, returns the same to the mouth, whence the honey is conveyed into the first stomach; part of it passes into the abdomen, and is manufactured into wax; the rest, on the arrival of the Bee at the hive, is deposited in a cell. The appendages of this organ, viz. the maxillæ and the labial palpi, also greatly assist the tongue in performing these marvellous duties.

The ligula, or tongue, on being separated from the insect, must be soaked for a short time in diluted potassa fusa, well washed, dried under strong pressure, placed in turpentine until transparent, and mounted in balsam.

Fig. 125.—*The Common Wasp* (*Vespa vulgaris*); natural size.
Order Hymenoptera.

The order Hymenoptera includes most of the architectural (or nest-building) insects, which are also noted for their great intelligence. The chief characteristics of the order are:—"Wings four, when at rest laid horizontally upon the body, membranous; posterior pair smaller, and with fewer veins, and generally having a series of hooks upon the costal margin; mouth generally furnished with the labium; mandibles two; abdomen of the females usually terminated by a sting or ovipositor; metamorphosis complete." The characters, according to fig. 137, the parts of the wasp mentioned in the description will be seen in their natural position as placed under the wings upraised. The Bees, Wasps, Ants, Gall-insects, Sawflies, Ichneumons, &c., all belong to this order.

Wasps, &c., may be mounted whole after prolonged maceration in tolerably strong solution of potash, well washing, drying under strong pressure, and then mounting in balsam.

Fig. 126.—*Tongue of Hive Bee* (*Apis mellifica*), × 20.

This tongue has been taken to illustrate the general structure of the tongues of the Bees and Wasps. It is as well adapted for suction as the proboscis or tongue of the Blow-Fly (see fig. 131), although of a different form; and it is also supposed to be the chief instrument which the Bee uses in the manufacture of her marvellous hexagonal cells. The Bee having sucked up sufficient honey from the flowers with this organ, returns the same to the mouth, whence the honey is conveyed into the first stomach; part of it passes into the abdomen, and is transformed into wax; the rest, on the arrival of the Bee at the hive, is deposited in a cell. The appendages of this organ, viz. the maxillæ and the labial palpi, also greatly assist the tongue in performing these marvellous duties.

The ligula, or tongue, on being separated from the insect, must be soaked for a short time in diluted potash first, well washed, dried under gentle pressure, placed in turpentine until transparent, and mounted in balsam.

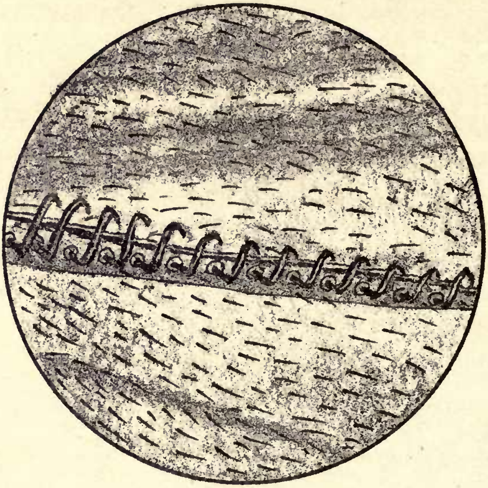

Fig. 147.

Fig. 148.

Jno. H. Martin, ad nat. del. Dickinson, I

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Fig. 147.—*Parts of the Wings of the Common Wasp, showing the natural position of the Hooks* (Vespa vulgaris), × 100.

The drawing represents the single row of hooks, when seen in their natural position—that is, when the posterior or smaller wing is hooked on to the larger, so as to appear to a superficial observer as one wing (see the natural insect, also the drawing of the same). This peculiarity is one of the structural characteristics of the order.

The wings are easily mounted, the best plan being to well wash them in warm water, place in their natural positions, dry under strong pressure between two slips of glass, soak in turpentine until transparent, and mount in balsam.

Fig. 148.—*Leg of the Neuter or Working Hive-Bee* (Apis mellifica), × 10.

Another fine structural organ or, rather, instrument of this order is the leg (see drawing). On noticing this, it will be seen that the first joint of the tarsus, or foot, is closely covered with a multitude of small stiff hairs; these form a kind of brush, with which the Bee brushes the pollen-dust from the anthers and stamens of flowers (see fig. 44) into the cavity made to receive the same. This basket, or cavity, is placed outside the brush, or first joint of the tarsus, and the joint of the leg called the tibia; the hinge which connects these two joints is marvellously strong, and also very flexible. It is a well-known fact that Bees never gather the pollen, but from one species, or at the most, from allied species of plants at each journey. The reason of this is, that pollens differ greatly in size (see figs. 40, 41, &c.), and by the laws of cohesion, particles of matter of various sizes cohere with much more difficulty than particles all of one size; the Bee, therefore, only gathers the pollen of one kind of plant on each separate journey. With this pollen the Bee makes her Bee-bread, with which to feed the larvæ.

The leg may be mounted as a transparent or opaque object; the mode of treatment is as usual.

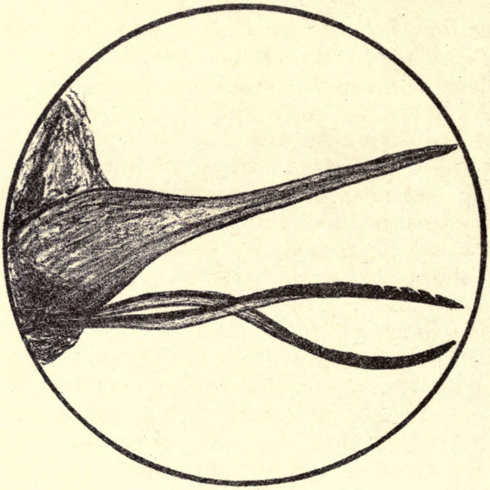

Fig. 149.

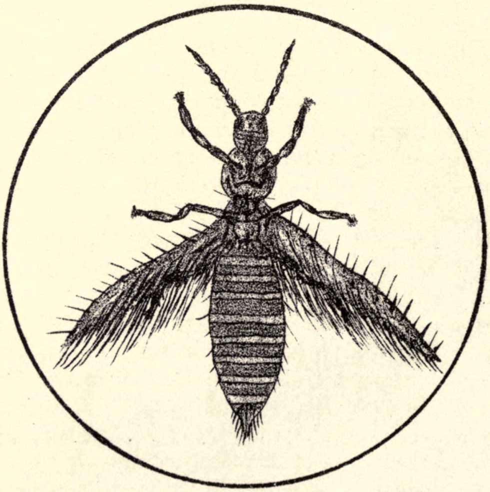

Fig. 150.

Jno. H. Martin, ad. nat. del.

Dickinson

London. John Van Voorst. MDCCCLXX.

Fig. 149.—*Sting of Hive-Bee* (Apis mellifica), × 20.

The sting may be considered as a modified form of ovipositor (see figs. 125, 130). It consists of a sheath, divided on the underside through its entire length; from this slit the setæ, or lancets, are protruded at will; these lancets are furnished at the extremity with fine teeth; the entire apparatus is supplied with very strong muscles, and both the sheath and the setæ can be withdrawn or protruded from the abdomen at pleasure. At the base of the sheath are two poison-glands, which poison, by the action of the setæ, is deposited in the wound made by them. The chief use of the sheath appears to be to protect the fine points of the setæ, or lancets, from injury.

After separating the sting from the insect, it must be softened by placing it in the diluted potassa fusa for a few hours, after which it must be well washed, and the lancets drawn out from the sheath with the point of a fine needle; they must then be placed in a natural position, dried under pressure, and mounted in balsam.

Fig. 150.—*A Small Fly* (Thrips physapus), × 20.
Order Thysanoptera.

This extremely small Fly, being only about $\frac{1}{16}$ inch in length, has been taken to illustrate the order. The chief structural peculiarities are:—"Wings four, alike, long, narrow, membranous, neither folded nor reticulated, with long cilia; mouth with two setiform mandibles, two triangular palpigerous maxillæ, and a palpigerous labium; tarsi 2-jointed, vesicular at tip." The *Thrips* may generally be found in the flowers of the small Bindweed or Convolvulus (*Convolvulus arvensis*); and in sultry summer weather scarcely a Convolvulus can be found without them.

Most flies are not at all difficult to mount; they must be macerated in the liquid potassa, according to size, from three or four hours to three or four days, then pressed gently between slips of glass, so as to force out the contents of the abdomen &c., then replace the insect in the potassa for a short time, well wash in warm water, dry under pressure, soak in turpentine until transparent, and mount in balsam as usual.

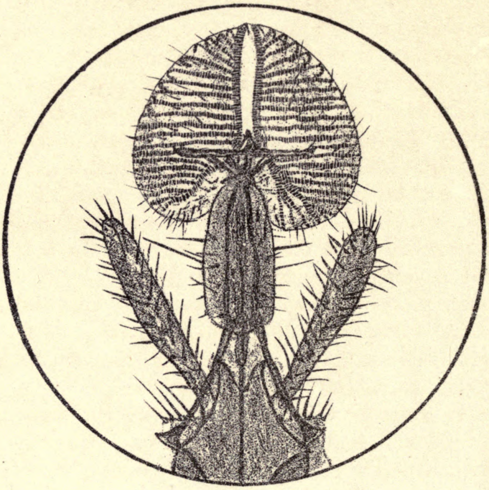

Fig. 151.

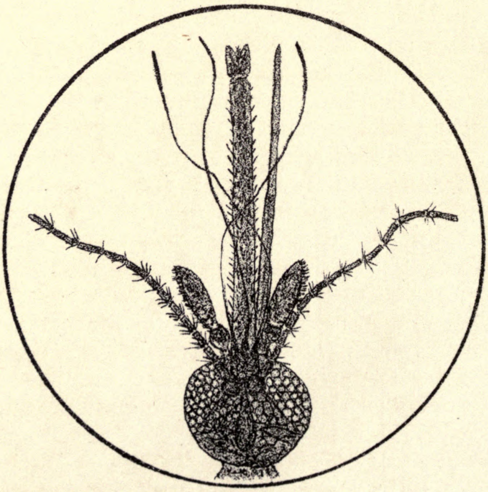

Fig. 152.

Jno. H. Martin, ad. nat. del.

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Fig. 151.—*Tongue of Blow-Fly* (Musca vomitoria), × 20.

One of the most marvellously constructed instruments with which insects are furnished is the proboscis, or tongue, of the Blow-Fly, to thoroughly describe which would take many pages. The broad part at the top of the drawing represents the two lobes of the ligula; these lobes contain a number of minute tubes, kept partially open by rings; and through these fine channels the fluid sugar is thoroughly filtered before it enters the mouth. A duct, which serves to convey a fluid with which to soften sugar and other substances, also runs into the tongue. Both of these necessary parts are kept in action by the muscularity of the pharynx, which part is at the bottom of the drawing. The contraction of this sends the salivary fluid to the food to moisten it, and the dilatation of the same forms a suctorial power, with which the liquid food is conveyed into the mouth.

The proboscis must be dilated by pressing the thorax of the Fly, then cut off with a fine pair of scissors (the Fly having been previously killed in alcohol), next placed gently in its natural position, squeezed flat, dried under pressure, soaked in turpentine until transparent, and mounted in balsam; or it may be mounted, without preparation, in glycerine.

Fig. 152.—*Lancets of the Female Mosquito* (Culex mosquito), × 10.

Another form of tongue is found in the Gnats, of which this drawing may be taken as a type. It consists of a labrum or tongue, which is the largest part (see drawing); another part, slightly smaller, called the labium, forms a kind of sheath for the mandibles and maxillæ, which in this case are generally called the setæ or lancets; they are four in number; three of them have been separated from the labium, or sheath, so as to show their structure, two of them being furnished with fine teeth, while the other two terminate in a fine sharp point. In addition to the irritation caused by the action of these setæ, a drop of poison is instilled by them into the wound, so as to render the blood more liquid for the suctorial action of the labium. The other parts represented in the drawing are the long pilose antennæ, and the two short and thick bodies called the maxillary palpi; the eyes are also shown.

These objects simply require to be placed in their natural position, dried under strong pressure, and mounted in balsam as usual.

Fig. 151.—*Tongue of Blow-Fly (Musca vomitoria).* ×20.

One of the most marvellously constructed instruments with which insects are furnished is the proboscis, or tongue, of the Blow-Fly, to thoroughly describe which would take many pages. The broad part at the top of the drawing represents the two lobes of the organ; these lobes contain a number of minute tubes, kept partially open by rings; and through these fine channels the fluid sugar is thoroughly [illegible] enters the mouth. A duct, which serves to convey a fluid with which to soften sugar and other substances, also runs into the tongue. Both of these necessary parts are kept in action by the muscularity of the pharynx, which part is at the bottom of the drawing. The contraction of this sends the salivary fluid to the food to moisten it, and the dilatation of the same forms a suctorial power, with which the liquid food is conveyed into the mouth.

The proboscis must be dilated by pressing the thorax of the fly, then cut off with a fine pair of scissors (the fly having been previously killed in alcohol), next placed gently in its natural position, squeezed flat, dried under pressure, soaked in turpentine until transparent, and mounted in balsam; or it may be mounted without preparation, in glycerine.

Fig. 152.—*Lancets of the Female Mosquito (Culex mosquito).* ×40.

Another form of tongue is found in the Gnats, of which this drawing may be taken as a type. It consists of a labium or tongue, which at the lowest part (see drawing) is rather [illegible] slightly swollen, called the labella, forms a kind of sheath for the mandibles and maxillæ, which in this case are generally called the setæ, or lancets; they are four in number; three of these have been separated from the labium sufficiently so as to show their arrangement, two of them being furnished with fine teeth, while the other one terminates in a fine sharp point. In addition to the irritation caused by the action of these setæ, a drop of poison is instilled by them into the wound, so as to render the blood more liquid for the suctorial action of the labium. The other parts represented are the antennæ and the long palpi, or feelers, and the two short but thick bodies called the maxillary palpi; the eyes are also shown.

These objects simply require to be placed in their natural position, dried under strong pressure, and mounted in balsam as usual.

Fig. 153.

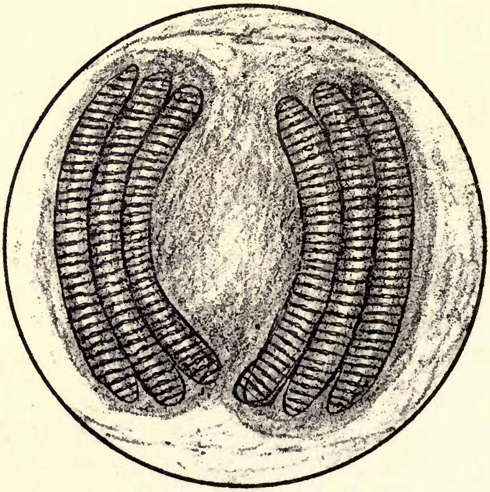

Fig. 154.

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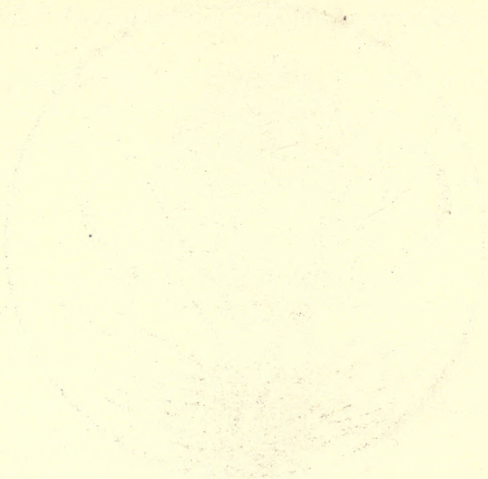
Fig. 153.—*Spiracle of Blow-Fly* (Musca vomitoria), × 40.

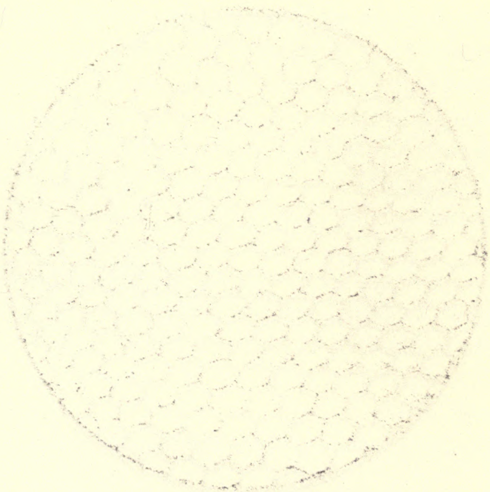
Other forms of spiracles are drawn in figs. 122, 139, &c.; the form is generally oval. To prepare this spiracle for mounting, the thorax of the Fly must first be macerated in a strong solution of potassa for two days, then cut open and well washed. A spiracle may then be cut away, and mounted separately; or the entire thorax with its four spiracles may be dried under pressure between two glass slips, soaked in turpentine until transparent, and mounted in balsam.

Fig. 154.—*Spiracle of the Breeze-Fly of the Horse* (Œstrus equi), × 20.

Another peculiar form of spiracle is drawn here; it rather represents a number of small spiracles massed into one. In the centre of each ring which passes round the worm-like bodies will be seen a small hole; through these fine holes the air passes into the tracheæ; and by the contraction of these worm-like bodies no doubt the holes are closed at will. The Breeze-Fly of the sheep (*Œstrus ovis*) has quite a differently shaped spiracle, although the characteristics of the structure are the same, viz. a number of minute holes closed at will by an elastic or flexible tissue.

The method of preparing this spiracle is the same as that given in the description of the preceding figure.





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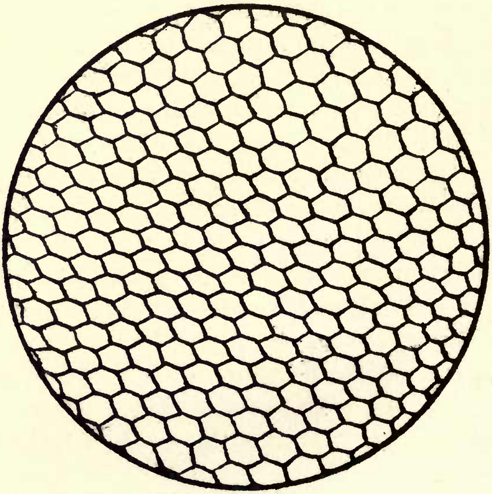

Fig. 156.

Jno. H. Martin. ad. nat. del.

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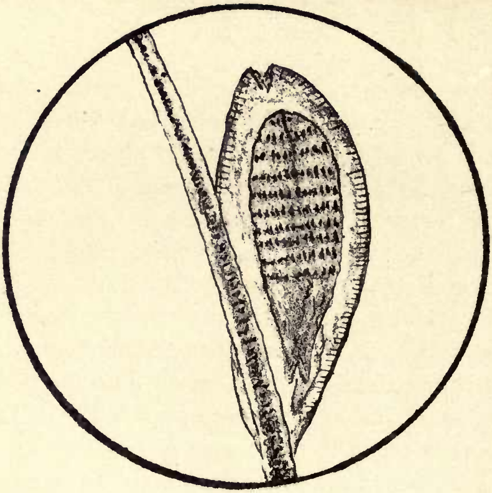
Fig. 155.—*Foot of a Fly* (Scatophaga stercoraria), ×80.

At the extreme end of the tarsus, or foot, in most flies, is found a small pad or cushion called the pulvillus. It is generally placed between two claws, or hooks (see drawing), and is supposed to enable the Fly, by its suctional action, to walk on smooth surfaces. The pulvillus is often covered with a number of disk-like hairs, and is also occasionally accompanied by a strong hair-like appendage. This must also greatly assist the Fly in walking over any smooth surface, as it would take advantage of any irregularity upon it. After the pad has been placed in its naturally extended position, it must be dried under very strong pressure, and mounted in balsam as usual.

Fig. 156.—*Eye of the Common House-Fly* (Musca domestica), ×200.

These facets are much smaller than those figured in fig. 137. The eyes of insects, as mentioned in the description of fig. 126, consist of a number of simple eyes, or facets, joined together at their angles, so as to form an oval convex surface protruding from the head, one on each side. In each single eye of the House-Fly there are about 4000 facets; and some insects, such as the Dragonflies &c., have even more than this.

After having macerated the eye in liquid potassa for about six hours, so as to clean it from blood &c., it must be well washed, a slit cut in it, then dried between writing-paper without much pressure, and mounted in a shallow dry transparent cell made of cardboard; or the entire eye may be mounted in a dry opaque cell without any previous preparation.



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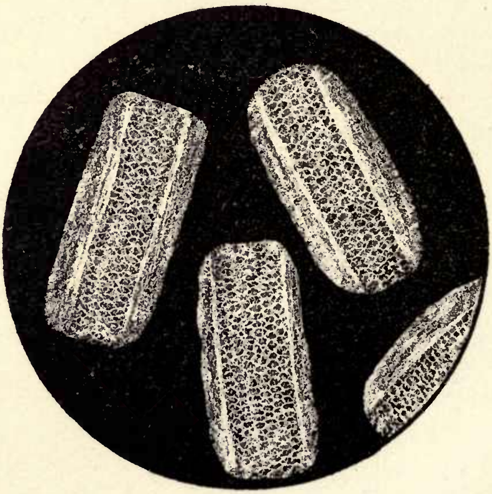

Fig. 158.

Jno H. Martin, ad nat del.

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Fig. 157.—*Larva of the Bot-Fly as seen in the Egg* (Œstrus bovis), ×40.

This Fly is extremely hairy: the head is covered with light yellow hairs; the thorax is also yellow and barred with black, the abdomen being partly black, but terminating in an orange-yellow colour. The Fly is much dreaded by cattle when in the open pastures. The insect generally lays its eggs under the surface of the skin, with an ovipositor adapted to the purpose; but occasionally they may be found on the hairs of the animal (see drawing). After the larva is matured by living on the flesh of the ox, it falls to the ground, and works under a stone or buries itself; it then passes into the cocoon-state, and in course of time emerges as a perfect Fly. The spiracle of a Fly closely allied to this insect is drawn in fig. 154.

The eggs, when found, may be soaked in turpentine, and mounted with Canada balsam, in a cell so as to take off all undue pressure.

Fig. 158.—*Eggs of a Species of House-Fly* (Anthomyia canicularis), ×40.

The Flies of the genus *Anthomyia* closely resemble the common House-Fly (*Musca domestica*), both in appearance and habits; but unlike the House-Fly they do not quite restrict themselves to habitations, being often found on plants of the field. The eggs of this species are of great beauty; they are generally deposited in the ground.

The eggs are best seen when mounted in a dry opaque cell.

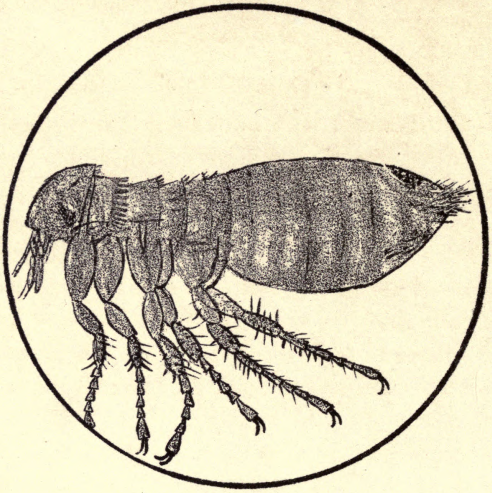

Fig. 159.

Fig. 160.

Jno. H. Martin, ad. nat. del.

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Fig. 159.—*Pigeon's Flea, female* (Pulex columbæ), ×15.
Order Aphaniptera.

The different species of Fleas are chiefly distinguished from each other by the different lengths of the joints of the leg and tarsus. The following is the description of the order:—"Wingless; metamorphosis complete; mouth suctorial; rostrum composed of two serrated laminæ and a thin suctorial seta (see fig. 162), included in a jointed two-valved sheath." The description of the species shown in the drawing is as follows:—"Prothorax with a pectinate fringe, none upon the abdomen; antennæ of male erect, those of the female lying in the depression." The abdomen of the female Flea generally has nine segments.

Most Fleas require to be macerated in the potassa for two or three days, then to be pressed between glass slips so as to remove part of the internal matter, replace them in the potassa for a short time, when the rest of the contents will soon come out under pressure; dry, soak in turpentine until transparent and mount in balsam as usual.

Fig. 160.—*Mouse's Flea, male* (Pulex muris), ×40.

The general outline of the male Fleas seems quite different from that of the females. Instead of the abdomen being in a line with the head and thorax, it is turned up as if the insect had been bent. The male insect has also erect antennæ (see drawing), and in the posterior legs the first joint of the leg, called the coxa, is rather larger than is commonly found in other species; and in the anterior and middle legs the last joint of the tarsus is also large.

The method of mounting is the same as in the preceding description, only that the species, being much smaller, requires less time in the potassa.

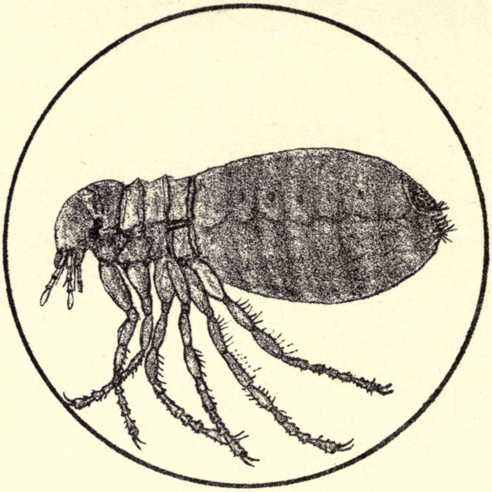

Fig. 161.

Fig. 162.

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Fig. 161.—*A Human Flea, female* (Pulex irritans), × 15.

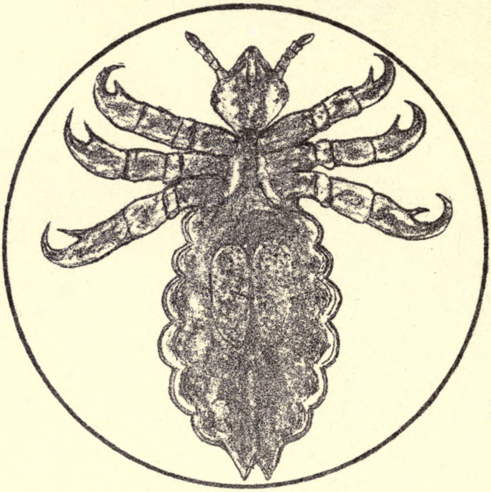
The human Flea has been drawn chiefly to show its similarity to the other species of Flea; but upon considering the description of the species, which is as follows, it will be found that the structural characters are slightly different:—Pitch-brown; head shining, smooth, pectinate fringe absent; legs pale; femora of the posterior legs with hairs inside; fifth joints of the tarsi of the anterior pair of legs the largest, and the first joints of the posterior tarsi the longest. The larvæ of this and other Fleas form interesting objects.

This species may be mounted in the same manner as the preceding.

Fig. 162.—*Lancets of Human Flea* (Pulex irritans), × 100.

Causing so much irritation, as these fine instruments do, when forced into our skin, we cannot but admire, after a microscopic view of them, their fineness of form and structure. The lancets, or mandibles, are on the right-hand side of the drawing, and may be distinguished by their serrated edges. Between them is the labrum, or the suctorial organ; the two antennæ-like bodies with four joints, at each side of the drawing, are the maxillary palpi; the shield-like bodies represent the maxillæ, and the 4-jointed labial palpi placed between these are the organs in which the lancets are sheathed when at rest.

The lancets, with the surrounding parts, require very careful mounting. The best plan, after they are cut off from the head of the Flea, is to place them in the centre of a glass slide, in a drop of balsam about the size of a pin's head, then with a fine needle to place them in their proper positions, after which, let the drop dry under a glass shade, so as to keep off the dust. When quite dry, place the thin cover on, and let diluted Canada balsam run in by capillary attraction, so as not to disturb the objects; finish as usual.



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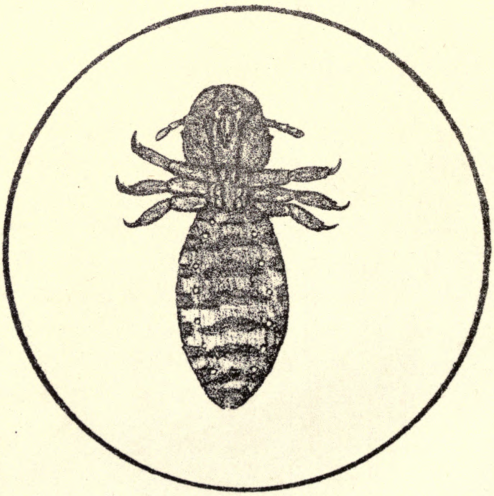

Fig. 164.

Jno H. Martin. ad nat del   Dickinson

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Fig. 163.—*A Human Louse* (Pediculus vestimenti).
Order Anoplura, × 16.

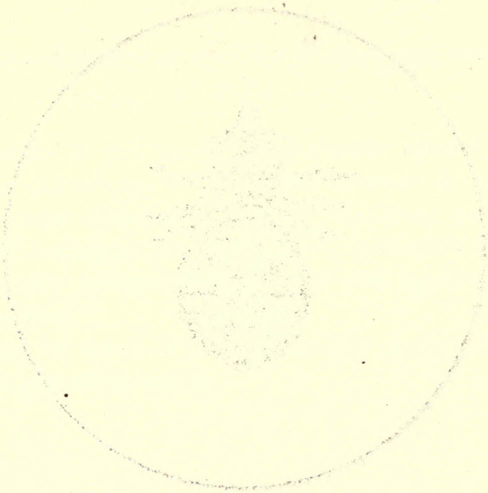
The description of this repulsive insect, which has been taken as a type of the order and genus, is as follows:—Colour dirty white; elongate-ovate; thorax large, not constricted from the abdomen; head much produced; antennæ 5-jointed; mouth with a fleshy rostrum concealed beneath the head, consisting of a soft tubular sheath dilated at the end, where it is furnished with a double row of hooks, and containing a horny tube formed of four setæ; abdomen with seven segments indistinctly indicated; legs all scansorial or prehensile; length about $\frac{1}{8}$ inch.

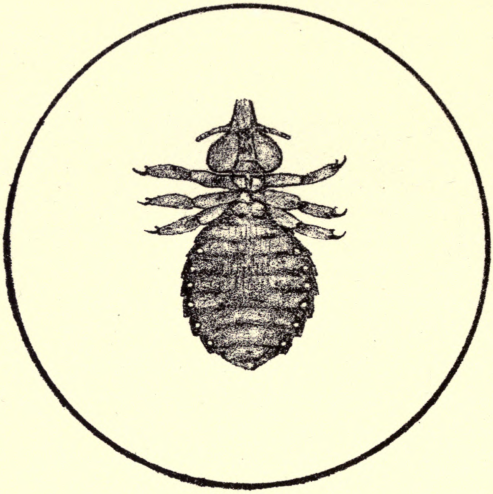
The insect may be mounted in balsam as usual.

Fig. 164.—*Parasite of Horse* (Trichodectes equi), × 20.

Other insects of the same order as the preceding are parasitic upon some quadrupeds, viz. the Horse, Sheep, Ox, Dog, &c., in all about ten species. The characteristics of the genus are:—Head subquadrate, with two black spots in front, and a black band on each side; antennæ filiform, 3-jointed; maxillary palpi none, or inconspicuous; mandibles 2-toothed; tarsi 2-jointed, with one claw; abdomen oval.

The insect usually only requires to be dried between writing or glazed paper, under moderate pressure, soaked in turpentine until transparent, and then mounted in balsam.





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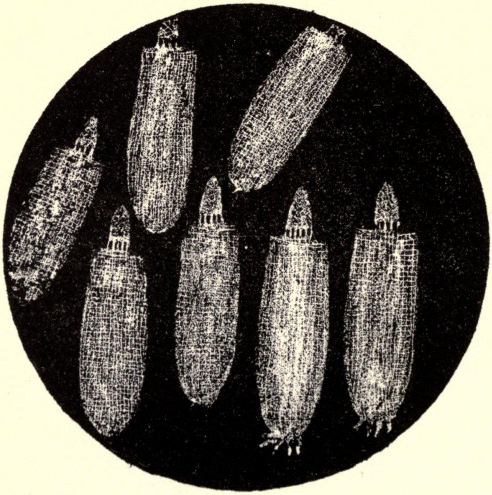

Fig. 166.

Jno. H. Martin ad. nat. del.

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Fig. 165.—*Parasite of Starling* (Philopterus leontodon), $\times 20$.

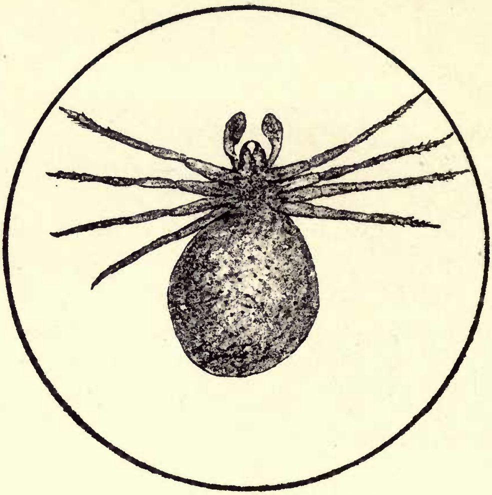
The insects of this genus are parasitic upon birds; the species are numerous. The characteristics of the genus are:—Antennæ filiform, 5-jointed; maxillary palpi none; mouth with strong toothed mandibles; tarsi with two claws; head generally triangular. Most of the species are of a chestnut-colour.

They may be mounted in the same way as described in the case of the preceding species.

Fig. 166.—*Eggs of Parasite of the Crowned Hornbill* (Buceros coronatus), $\times 25$.

Many of the eggs of the insects belonging to the order Anoplura are most beautiful in form and structure, and possess also the great advantage of not having been at present much studied. No doubt, if the hairs of animals and the feathers of birds were well examined, microscopists would find abundance of beautiful forms at present unknown, or nearly so. The eggs of many other orders of insects will also be found most interesting (see figs. 143, 144, 158, &c.).

The eggs generally show best when mounted in a dry opaque cell.



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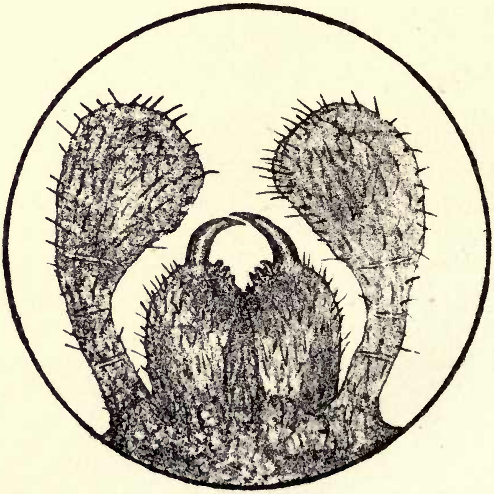

Fig 168.

Jno H. Martin. ad nat. del

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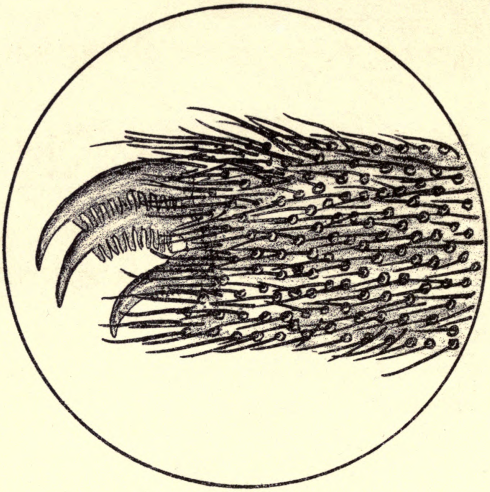
Fig. 167.—*House-Spider* (Aranea domestica), × 3.
Class Arachnida.

The Class Arachnida, which comprises the Spiders, Mites, &c., does not belong to the Class Insecta proper, but is placed between them and the higher articulated animals. The description of the order is as follows:—Head united with the thorax, forming a cephalothorax; antennæ none; eyes simple (ocelli); legs eight, jointed. The organs of the mouth vary according to the families; in the Araneida, or the true Spiders, they chiefly consist of mandibles (see fig. 168), and in the Mites they often terminate in a bifid labium. Spiders may be mounted in the same manner as any whole insect, viz.—with a fine needle prick a small hole in the abdomen, then immerse in liquid potassa fusa for a few hours or days according to size, next press gently between glass, replace in the potassa for an hour or so, then press the rest of the matter from the body. Well wash in warm water, dry under pressure, soak in turpentine, or distilled Canada balsam, until transparent; finally mount in balsam as usual.

Fig. 168.—*Mandibles of the House-Spider* (Aranea domestica), × 20.

The mandibles as mentioned at fig. 167, comprise the chief part of the mouth of a Spider; they are the two claw-shaped bodies in the centre of the drawing; each claw is pierced nearly through so as to admit of a poisonous secretion passing from the gland situated at its base up the canal and through the small hole near its apex into the body of the insect attacked, by a similar action to that of the sting of the nettle (see fig. 35). On each side of these mandibles are situated the maxillary palpi, and at their base are the maxillæ; lastly between these is the labium.

The method of preparation is the same as mentioned for parts of insects (see figs. 141, 155, &c.).



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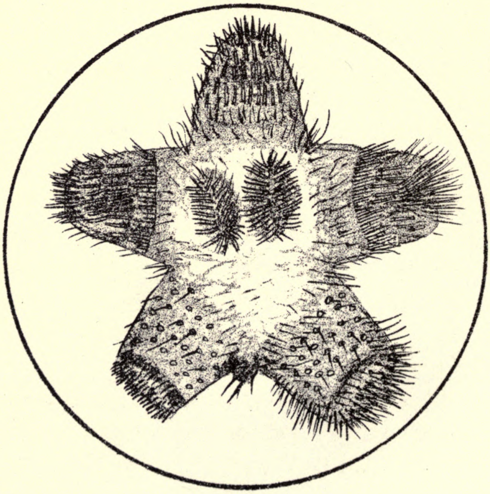

Fig. 170.

Jno. H. Martin, ad. nat. del.

Dickinson, In

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Fig. 169.—*Foot of the Garden-Spider* (Epeira diadema), $\times 60$.

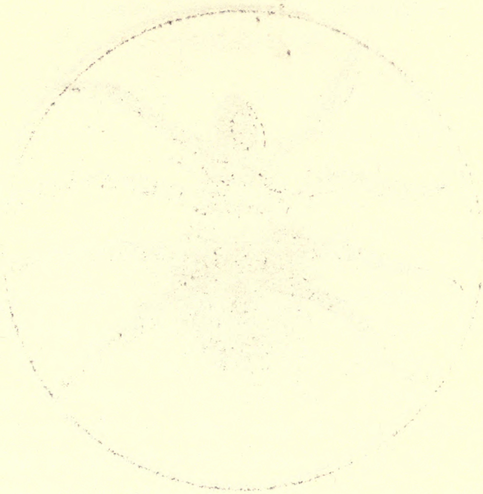
The leg of a Spider, as will be seen on referring to the drawing, is admirably adapted for its work; the last joint of the tarsus being generally furnished with three saw-like claws, by means of which the Spider is enabled to retain its hold upon the web and to pass down any part of the same with great rapidity.

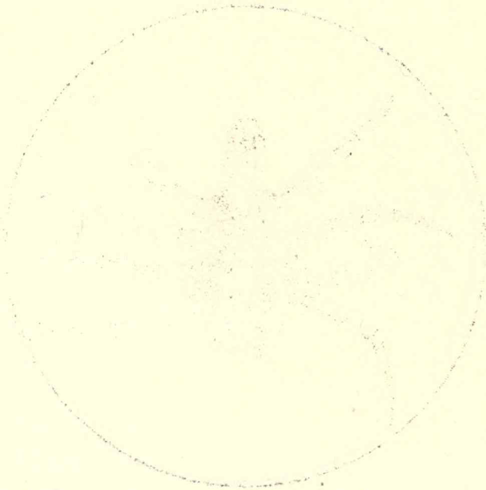
The leg simply requires to be well washed with a camel's-hair brush, dried under pressure, soaked in turpentine, and mounted in balsam.

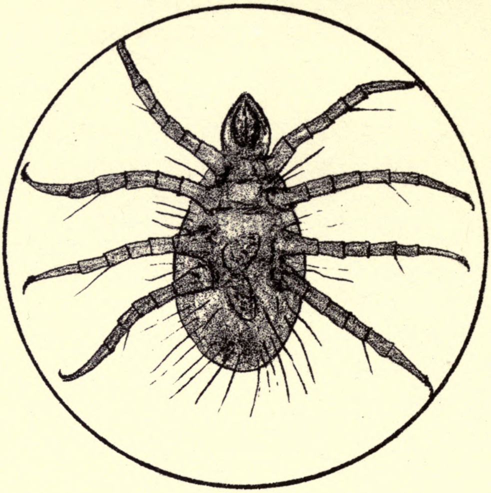
Fig. 170.—*Spinnerets of the Garden-Spider* (Epeira diadema), $\times 20$.

At the base of the abdomen are situated three pairs of conical-shaped bodies, these are the spinnerets; and on referring to the drawing a number of minute tubes will be seen on the summit of each. From these tubes the viscid matter is drawn in single filaments, and it collects into one extremely fine thread, with which the Spider manufactures it web. The number of these spinning-tubes varies from about 1000 to 100 according to the age of the insect &c. The bases of the spinnerets are closely covered with hairs to protect the tubes from injury. The glands which secrete the viscid matter of which the web is composed occupy the interstices of the other viscera of the abdomen.

The part containing the spinnerets simply requires to be placed in liquid potassa for two or three hours, well washed, dried under pressure, and mounted in balsam.







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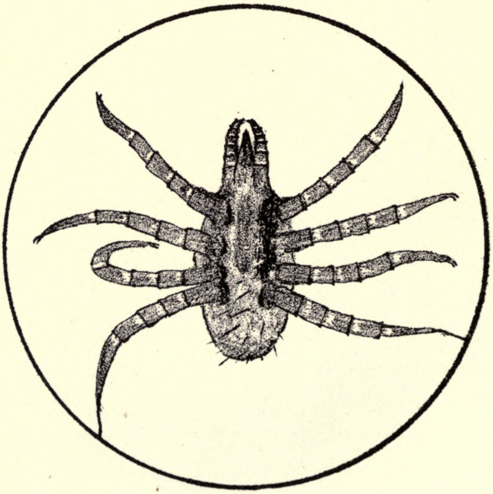

Fig. 172.

Jno. H. Martin, ad. nat. del.

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Fig. 171.—*Cheese-Mite* (Acarus domesticus), × 100. Order Acarind.

A large division of the Class Arachnida is comprised in the Order Acarina, or Mites, of which this drawing may be taken as one of the types. This well-known animal belongs to the same family as the Itch-parasite (see fig. 175), the most evident difference in their structure being the length and position of the legs; the description of the family (*Acarea*) is as follows:—Head terminated in front by an emarginate labium or single bifid process; palpi adnate, or adherent to the labium, difficultly distinguished; mandibles chelate; no distinct ocelli; legs generally terminated by a vesicle or adherent acetabulum and claws. The eggs are very numerous. The best method to examine the characters of the parts of the mouth, legs, &c., is simply to crush the Mite between thin glass, and wash with a solution of potassa; but to permanently preserve them great care must be taken in crushing them. After being well cleaned from the potassa, they may be dried and mounted in balsam; or they may be mounted in glycerine without any previous preparation.

Fig. 172.—*Parasite found on a Mason-bee* (Trichodactylus osmiæ), × 20.

This Mite belongs to the same family as the Cheese-mite, but to a different genus. The description is as follows:—Rostrum or beak short, with minute bristles; fourth pair of legs longer than the rest, without claws, and terminated by a long bristle; the rest with two claws; legs pale red. Found upon a species of Mason-bee.

It may be mounted in the same manner as the preceding species. Many of the *Acari* show well after being stained with any of Judson's dyes, and then mounted in glycerine.

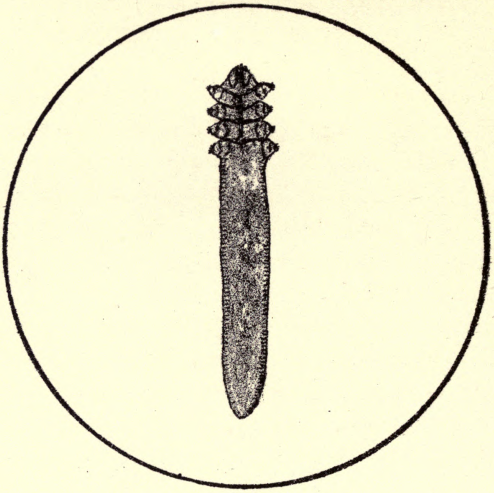

Fig. 173.

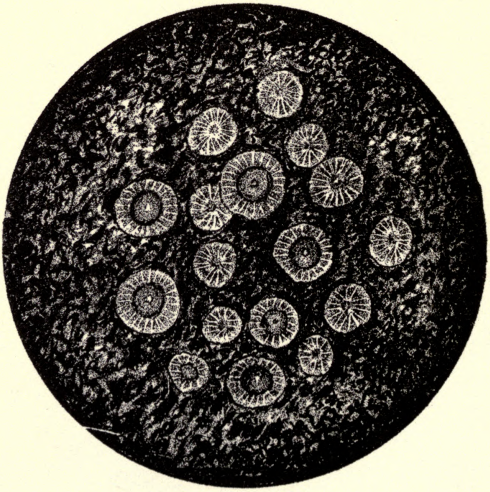

Fig. 174.

Jno. H. Martin, ad. nat. del.

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Fig. 173.—*Skin-Parasite from Human nose* (Demodex folliculorum), × 200.

The exact position, as regards the classification of this parasite, is rather doubtful; at present it is classed under the family Acarea. On the nose and the parts adjacent, it is generally to be seen in large numbers; its presence is always denoted by a minute black spot. The characters of the genus are:—Legs terminated by four or five claws; no acetabula; abdomen annulose.

On the skin that contains these parasites being pressed, from each black spot proceeds a small quantity of mattery substance; this contains the parasite, and also often a number of ova. The mass may be placed at once in the carmine-dye, and then transferred to a drop of glycerine; next place it on a glass slide, cover with thin glass, and then gently press the dyed matter, after which, if a ¼-inch power is used, the parasite will be distinguished from the surrounding mass.

Fig. 174.—*Eggs of Earth-mite* (Tetranychus lapidum), × 40.

The beautiful eggs of this mite may often be found on the inside of the rough pieces of bark that are commonly seen on old Elder trees &c; they are also found on stones. The description of the species is:—Legs slender, anterior very long; eyes three on each side; several rows of white spots upon the back and margins of the body.

The eggs show best when mounted in a dry opaque cell.

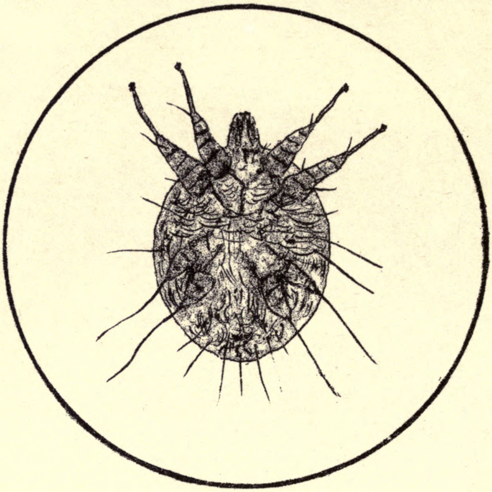

Fig. 175.

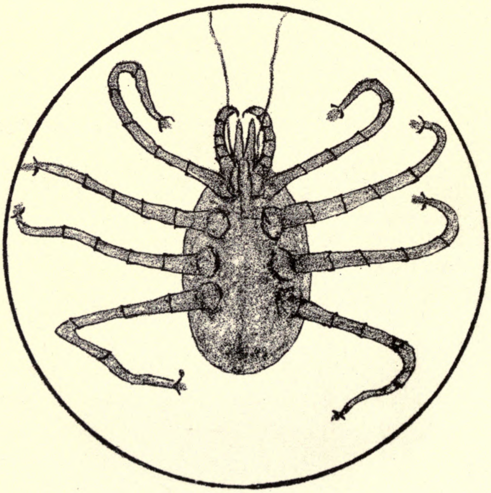

Fig. 176.

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Fig. 175.—*Itch-insect, female* (Sarcoptes scabiei), × 60.

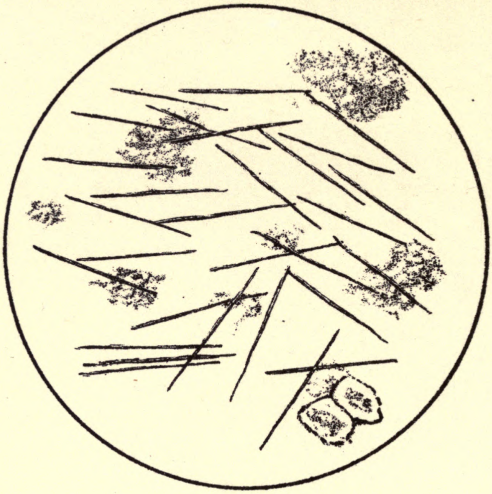
The Itch-insect belongs to the same family as the Cheese-mite. The parasite is chiefly remarkable for causing the disease called the Itch. The description of the parasite is as follows:—Head small, somewhat narrowed in front; mandibles toothed; anterior two pairs of legs separated from the posterior by a considerable interval: legs short, the anterior two pairs with acetabula or adhesion-disks, 5-jointed; the posterior 3-jointed, the last joint terminated by a long seta and without acetabula. Male insect about half the size of the female, and with acetabula to the hindermost pair of legs.

The parasite shows best when mounted in a cell with chloride of calcium or glycerine.

Fig. 176.—*Parasite of Watchman-Beetle* (Gamasus coleoptratorum), × 20.

Another parasite of the order Acarina is commonly found on the Dung- or Watchman-Beetle (*Geotrupes stercorarius*) as it is popularly called. The description of the species is as follows:—Anterior coxæ attached at a little distance from those of the second pair; tarsi with two claws and an elegant caruncle; palpi free, filiform; mandibles chelate; ocelli none or indistinct.

The parasite may be cleaned, dried under pressure, and mounted in balsam as usual; or it may be mounted in a cell with chloride of calcium, acetic acid, or glycerine.



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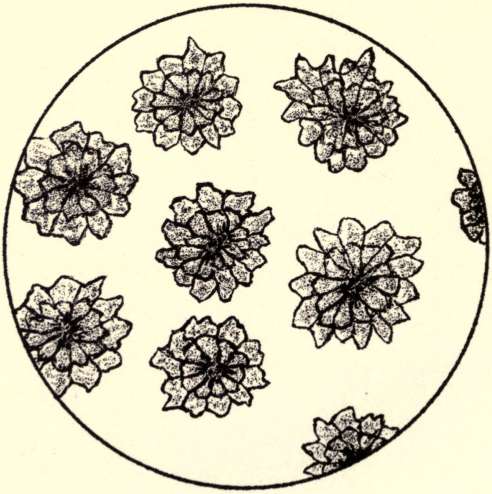

Fig. 178.

Jno. H. Martin, ad. nat. del.   Dickinson,

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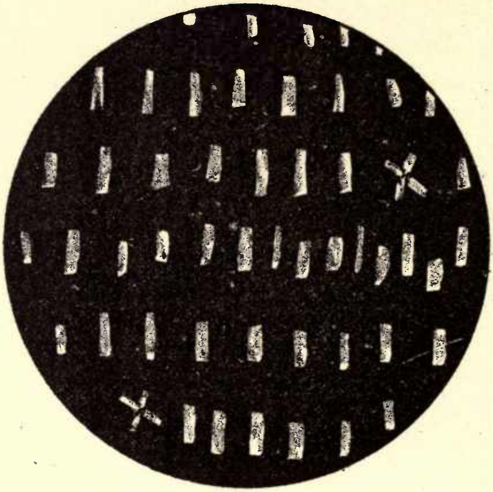
Fig. 177.—*Raphides from the Hyacinth* (Hyacinthus orientalis), × 200.

Raphides are minute crystals, chiefly found in the cellular tissue of plants; they are most abundant in the Natural Orders Liliaceæ, Cactaceæ, Polygonaceæ, Orchidaceæ, &c. Most of the forms show well under polarized light. They are composed of the various salts of lime, viz. the oxalate, carbonate, sulphate, and phosphate of lime. The following tests for these raphides may be useful:—Upon the application of a small drop of acetic acid, the presence of the phosphate or carbonate is immediately perceived, as both of these salts dissolve with effervescence, while neither the oxalate nor the sulphate is altered: for their tests, see fig. 179. To distinguish the phosphate from the carbonate, an excess of ammonia must be added, when, if phosphate of lime is present, it will be developed as minute granular matter.

Fig. 178.—*Raphides from Turkey Rhubarb* (Rheum palmatum), × 200.

These raphides consist of oxalate of lime, each stellate group being composed of a number of rectangular crystals, so arranged by the natural deposition of the salt in any single cell as to partake of the stellate form. An artificial formation of these stellate crystals may be obtained by placing rice-paper or elder-pith in a solution of chloride of calcium, exhausting the air in the cells by placing under an air-pump, then straining off the chloride, and adding a saturated solution of oxalic acid; after which, occasional stellate crystals will be found. This experiment may be tried with the other salts of lime.

Raphides are best seen when mounted in Canada balsam.



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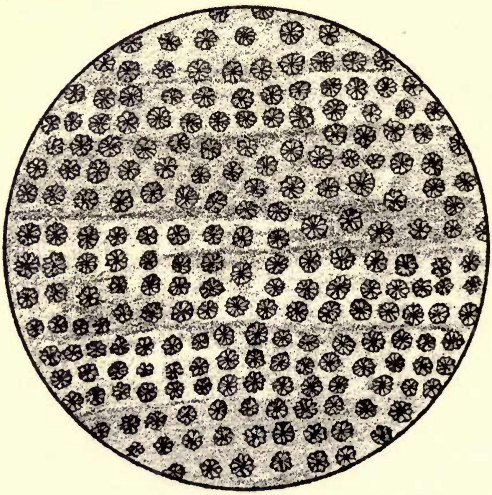

Fig. 180.

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Fig. 179.—*Raphides in the Cuticle of the Onion* (Allium Cepa), × 120.

The raphides in this cuticle consist of crystals of oxalate of lime. They are drawn as seen under polarized light.

On testing them with sulphuric acid, minute crystals of sulphate of lime are formed (see fig. 182), the sulphuric acid having a greater affinity for the lime than the oxalic acid has. If the crystals had been composed of sulphate of lime, scarcely any change would have been perceived.

The tests for the carbonate and phosphate of lime are mentioned under fig. 177.

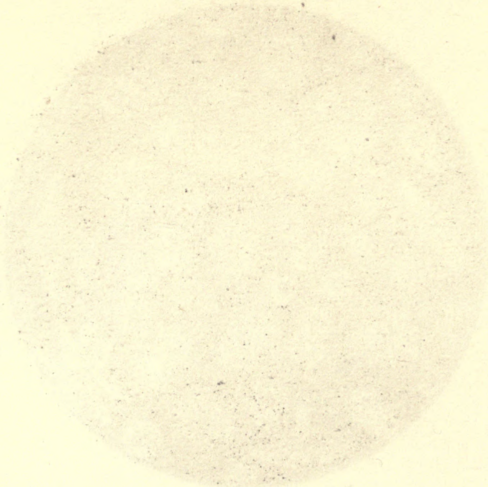
The cuticle is best seen when mounted in balsam.

Fig. 180.—*Raphides in the Sepal of a Geranium* (Geranium Robertianum), × 200.

The minute stellate crystals which occur in such large numbers in the sepals &c. of most of the species of this genus (*Geranium*), are composed of oxalate of lime. The presence of raphides in any plant is easily ascertained by the use of the polariscope, as all the forms polarize well.

It is not known that these vegetable crystals are of use in the nutrition or structure of plants; but they are no doubt caused in an accidental manner, by the various acids meeting with calcareous matter, uniting with it, and forming these vegetable salts.

The sepal may be placed in turpentine, and mounted in balsam in the usual manner.



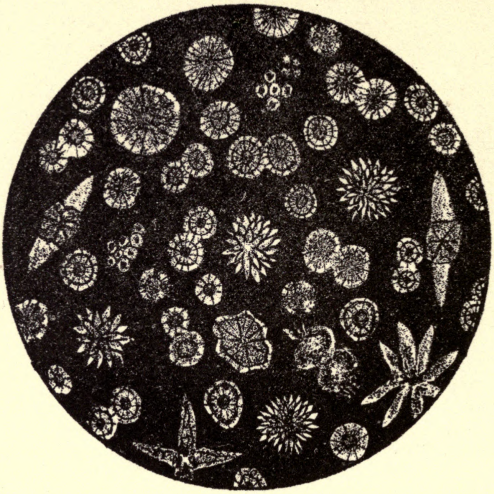


Fig. 181.

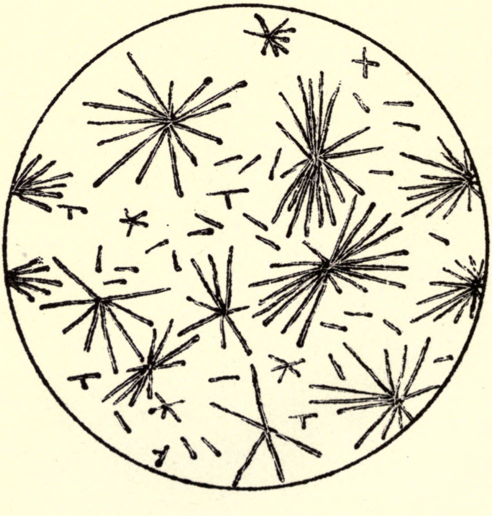


Fig. 182.

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Fig. 181.—*Crystals of Carbonate of Lime,* × 80.

Chalk (see fig. 102), marble, limestone (figs. 191, 192, 194), coral, &c. are composed of carbonate of lime. It also occurs in bone, shells, &c., and is, moreover, often found in the animal secretions. From it all the salts of lime may be formed.

The drawing illustrates the various forms of the crystals as seen under polarized light.

These crystals may be mounted in balsam.

Fig. 182.—*Crystals of Sulphate of Lime,* × 100.

The crystals of this salt of lime may be prepared by adding sulphuric acid to chloride of calcium. Or it may be prepared from carbonate of lime by the addition of the same acid. The size of the tufts of needle-shaped crystals varies greatly. The preparation from which the drawing was made was evaporated from a hot saturated solution of the salt and mounted in a cell with castor-oil.

Sulphate of lime is found in its natural state as gypsum, alabaster, selenite, &c. It often exists in hard water, which, on the addition of carbonate of soda, is softened by precipitating the lime as a carbonate. The salt is not very soluble in water.

Fig. 183.

Fig. 184.

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Fig. 183.—*Crystals of Chlorate of Potash,* ×40.

One of the best of the polarizing crystals is chlorate of potash; but other salts of potash are almost equally interesting (see fig. 184).

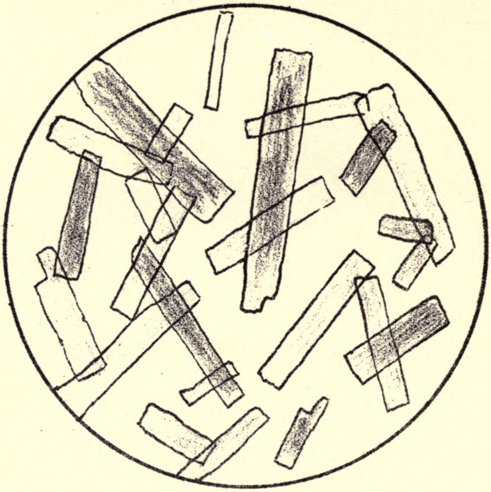
To obtain a constant form of crystal from any salt requires a certain amount of practice. The methods vary. Some crystallize best from a saturated solution in alcohol, others in warm or cold water; some, like salicine, require to be fused, &c.; but for micro-chemical analysis a saturated solution in cold water is perhaps best, as being least liable to interfere with the test used.

The crystals are drawn as seen under polarized light.

Fig. 184.—*Crystals of Bichromate of Potash,* ×40.

From a hot saturated solution of this salt in water, beautiful feathery crystals are formed, which, together with many other crystals, have the property of analyzing polarized light (see fig. 185). To show this power well, the crystals of this and of the other salts, such as the nitrate of potash, sulphate of magnesia, &c., are best mounted in balsam.

Although many crystals can scarcely be mounted at all on account of their deliquescence, still the majority may be mounted in castor-oil, glycerine, or Canada balsam, and many others may be mounted dry.



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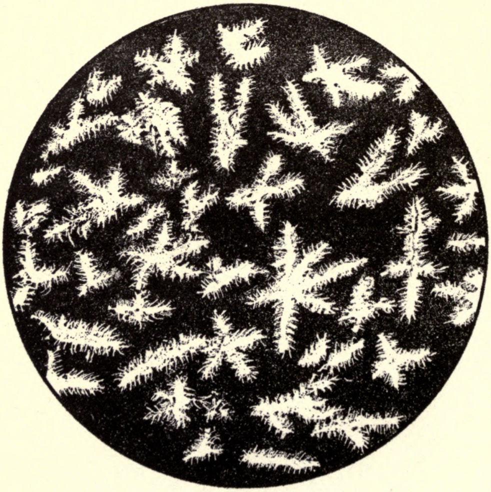

Fig. 186.

Jn. H. Martin, ad. nat. del. Dickinson.

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Fig. 185.—*Crystals of Oxalic Acid,* $\times$ 40.

As mentioned at fig. 184, some crystals have the power of analyzing polarized light. Sulphate of magnesia, which crystallizes somewhat similarly to oxalic acid, can therefore scarcely be distinguished from it, either in regard to its form or power of polarization. But by adding a drop from the test-bottle of chloride of calcium, the sulphuric acid of the sulphate of magnesia, having a greater affinity for the lime than for the magnesia, combines with it, and forms tufts of the needle-shaped crystals of sulphate of lime (see fig. 182); while upon applying the chloride of calcium to the oxalic acid, rectangular crystals of oxalate of lime are chiefly formed.

The crystals are best seen when mounted in balsam.

Fig. 186.—*Feathery Crystals of Boracic Acid,* $\times$ 40.

These crystals may be prepared as follows:—To a hot saturated solution of borax in water, add $\frac{1}{4}$ part of sulphuric acid; as the liquid cools, crystals of boracic acid are deposited at the bottom of the test-tube. The mother liquor must then be poured off, and the crystals dried. If the feathery form is wanted, they must then be dissolved in alcohol, a drop evaporated on a glass slide, and castor-oil immediately applied. Next cover with thin glass, and seal the cover as usual. Even with these precautions the crystals will not often keep long, as they are extremely deliquescent.

If the solution of borax be treated with phosphoric acid, and the water mixed with the crystals deposited from the mixture be evaporated on the slide, minute disks will occasionally be found. When mounted in Canada balsam and examined under polarized light, crosses will be observed rotating round the centres of these as the polarizer is moved.

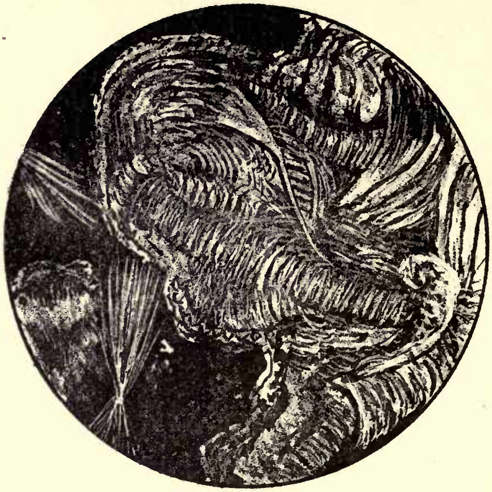

Fig. 187.

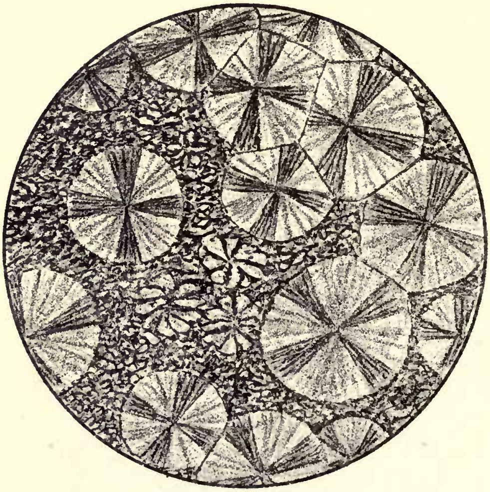

Fig. 188.

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Fig. 187.—*Plumose Crystals of Quinidine,* × 20.

Quinidine is an alkaloid or vegetable alkali, found in Peruvian bark, and usually associated with quinine, which it closely resembles. It is not readily soluble in water, but freely in alcohol. The solution, when evaporated, yields the plumose crystals, the great beauty of which, under polarized light, has caused me to draw the reader's attention to the same. The crystals show best when mounted in balsam.

Fig. 188.—*Crystals of Salicine,* × 12.

These crystals present the same appearance of rotating crosses as the crystals of boracic acid, mentioned at page 93. The method of preparation is, to evaporate from a hot solution in alcohol, or to fuse a small quantity of the salicine over a gas-jet or spirit-lamp until it dissolves, then to run the semifluid mass over the slide; and generally the disks will appear upon the cooling of the glass. If deposited from a solution, it is often found to be the best plan to confine the drop with a wall of varnish or thick gum previously dried. Other forms of interesting crystals which exhibit the cross are boracic acid, sulphate of cadmium, oxalurate of ammonia, &c.

Some of the crystals which exhibit the cross have been drawn in fig. 181. The crystals of salicine are best seen when mounted in balsam.

Fig. 189.

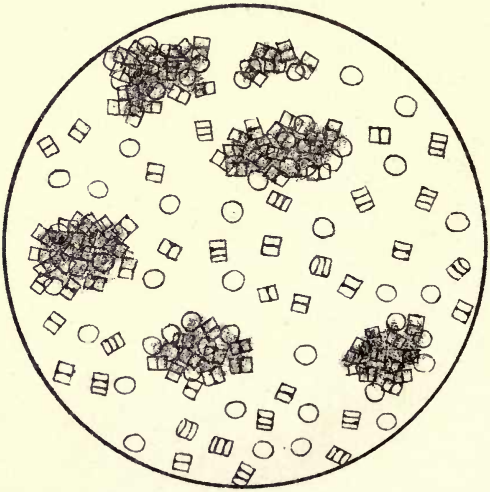

Fig. 190.

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Fig. 189.—*Section of Sandstone from Cherbourg Works, France,* ×40.

The drawing is taken from the section of this rock as seen under polarized light. This rock is a true siliceous sandstone, and is composed of subangular fragments of nearly pure quartz, cemented together by a small amount of siliceous matter; it also contains occasional specks of clay and oxide of iron.

The microscopical investigation of rocks is of great value to the geological student.

Fig. 190.—*Siliceous Infusorial Earth from Bilin, Bohemia,* ×400.

There are found in many parts of the world rocks composed almost entirely of minute siliceous skeletons of an order of confervoid Algæ called Diatoms (compare the drawing with a recent form of Diatom represented at fig. 98). These minute organisms were long thought to belong to the animal kingdom; and it is only within the last few years that they have been thoroughly studied and classified.

This rock, like chalk, belongs to the sedimentary formations.

Fig 191.

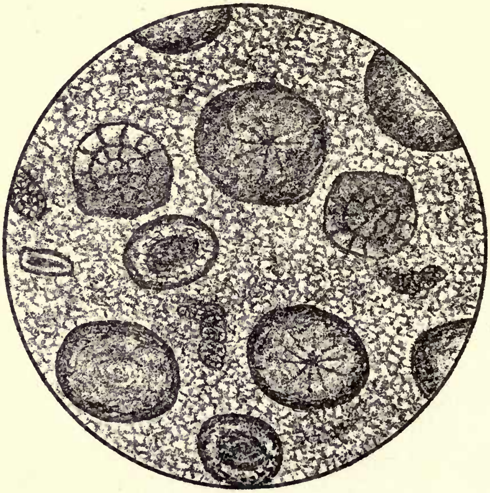

Fig. 192.

Jno. H. Martin, ad nat. del. Dickinson, I

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Fig. 191.—*Section of Eocene Nummulitic Limestone from Gerona,* × 6.

This section, together with that represented in fig. 192, belongs to the calcareous division of rocks. It is a sedimentary formation.

The Nummulites seen in this section are Foraminifera; and the limestone itself is an important member of the Eocene formation, being well developed throughout an extensive area in Southern Europe, and even still further eastwards to India.

Fig. 192.—*Foraminifera in the lowermost Bed of Carboniferous Limestone, from Bristol,* × 20.

This limestone, which often attains a great thickness, is tolerably compact and argillaceous, and retains in a great measure unaltered the structure due to sedimentary deposition, so that the organic remains are well preserved. Amongst the Foraminifera is the genus *Fusulina.* Compare the forms with the comparatively recent Foraminifera as seen in figs. 103, 104, &c.

It is a sedimentary formation.

Fig. 193.

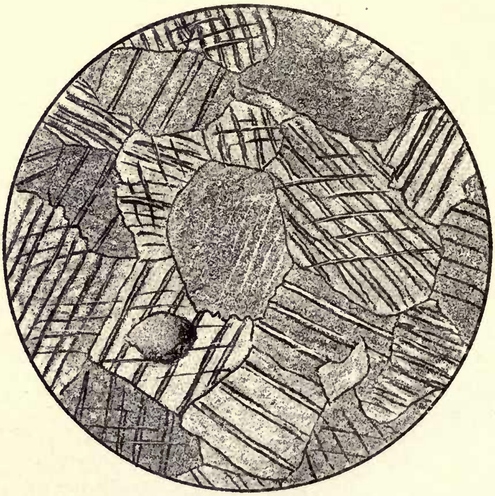

Fig. 194.

Jno. H. Martin, ad nat. del

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Fig. 193.—*Section of Oolitic Argillaceous Shale from Arica, Peru,* × 40.

This rock belongs to the oolitic system, so called from most of the rocks having the appearance of minute round bodies similar to the eggs of fish, as in the figure, this appearance arising from the globular deposit of carbonate of lime around grains of sand.

It belongs to the sedimentary formations.

Fig. 194.—*Section of Marble taken from the Temple of Diana at Ephesus,* × 20.

The beautiful appearance of this rock under polarized light can scarcely be appreciated from the drawing, as the several colours of the various particles are necessarily wanting.

It belongs to the metamorphic rocks.

APPENDIX.

The following notes and remarks will be found useful as a slight guide to the preparation and mounting of objects. The student must not be discouraged at his want of skill if he does not succeed even after three or four attempts; for, like most things, success comes with patience and practice. The things chiefly required are patience, delicate touch, and good eyesight; if these are combined, success is certain. Delicacy of touch is generally acquired in time; so the want of that need not discourage. The first thing, of course, is the choice of a working microscope. There are so many good makers that it is scarcely necessary to mention any particular name; but, perhaps, the cheapest is Field's (of Birmingham) Prize Microscope; the cost is three guineas; and Students' Microscopes from about £5 are made by the best opticians: for a superior article, as the cost increases, Smith and Beck's Popular Microscope, price £10, will be found a good working instrument. To this microscope may be added superior object-glasses &c., if wanted. The better microscopes range from this price up to about £190. The next thing to consider is the apparatus that the student will require for observing and mounting the various structures that may be taken from the vegetable and other kingdoms. Having decided upon the choice of a

microscope, some of the following apparatus will be required:—

1-inch object-glass.	Condenser.	Micrometer*.
¼-inch object-glass.	Polariscope.	Live-box.
A eye-piece.	Spectroscope*.	Paraffin lamp.
B eye-piece*.	Parabolic reflector*.	Fiddian's lamp*.

N.B. Those articles that are marked with an asterisk may be procured gradually, together with the higher powers &c.

The following tools &c. must also be purchased or made at the same time:—

An air-pump.
Propagating or bee-glasses, three or four.
The cup parts of broken wine-glasses; the bottoms may also be used as covers.
Dipping-tubes, made by holding glass tubes in a gas-jet until soft, and then drawing out to a fine point.
Test-tubes: each of these may have a small dipping-tube placed in the cork, so as to reach to the bottom.
Forceps, one or two.
Camel's-hair pencils, various sizes.
Scalpels, two or more.
Razor mounted in wooden handle.
Scissors, two pairs; one fine-pointed, one common.
Pneumatic trough or a large globe or dish for holding waste water, in which to wash slides, test-tubes, &c.
Needles, three or four sizes, mounted in small cedar handles.
One large ditto ground down to a cutting-edge (like a chisel), for separating and cutting minute fibres &c.
A fine thread of spun glass fixed in a handle, used for isolating minute objects, such as Diatoms &c.
Spirit-lamp.
Tripods, two or three, or a retort-stand.
American paper-clips (these can be procured at most stationers').
Small white porcelain cups: can be obtained of any artist's colourman.
Pumphrey's ebonite cells.
Watch-glasses.
Glass funnel.
Turn-table.
Section-cutter.
Pill-boxes (various sizes).
Liebig's extract-of-meat jars (empty).
Writing diamond.
Small homœopathic bottles.

Files.
Fine saw mounted in wooden handle.
Punches, two or three.
Hammer.
Wooden block.
Pliers, two pairs, one of them cutting.
Old knives.
Glass slips, 3×1 inch.
Thin glass: squares $\frac{1}{2}$ oz., circles $\frac{1}{2}$ oz.
Wire, &c.

The following chemicals &c. will also be wanted :—

Solution of gum arabic in bottle with brush in the stopper of the same.
Glass bottle with a glass tube in the stopper, filled with Canada balsam.
Distilled water (with a lump of camphor in it to prevent any confervoid growths &c.) in a large stoppered bottle.
Liquid potassa fusa, strength 1 part potassa to 8 parts water.
Distilled Canada balsam.

Turpentine.	Chloride of calcium.
Ether.	Silicate of potassa.
Ammonia.	Lime-water.
Benzole.	Test-papers.
Chloroform.	Sulphuric acid.
Glycerine.	Nitric acid.
Alcohol.	Hydrochloric acid.
Methylated spirit.	Acetic acid.
Essential oil of lemon.	Gum-dammar.
Syrup.	Marine glue.
Judson's dyes, three colours.	Caoutchouc cement.
Nitrate of silver.	Berlin black (a varnish).
Iodine.	Gutta percha, &c.

Having now mentioned nearly all the things requisite for an amateur, we will next proceed to the preparation and mounting of a few objects, so as to give the reader an insight into the matter.

There are three forms of mounting chiefly used, viz. in balsam, dry, and in fluid or semifluid. All these methods should be tried upon the matter that may come into the student's hands, as the full structure and beauty is often lost from the specimen being mounted in an imperfect manner. Canada balsam, although it has its faults, appears to be at present the most reliable substance in which the

majority of transparent objects may be mounted. Most insects and the parts of the same are mounted in balsam; they must be placed in the potassa solution from six hours (or less) to as many days, according to the softness or hardness, or transparency or opaqueness, of the object; experience will give the time. They must then be put under a slight pressure so as to squeeze out part of the extraneous matter; replace in the potassa solution for a short time, then put them under increased pressure until cleared of the rest of the contents, when they must be placed in a large quantity of warm water for a few hours. It is best not to touch the object at this stage even with a camel-hair brush; but the vessel of water must be repeatedly shaken and extra water added, so as to thoroughly clean the specimen from the potassa (this is important); it must then be taken out of the water and dried between two slips of glass. All the pressure requisite for a small object is obtained by the use of the American paper-clips; but if the object is large and thick (as, *e.g.*, many of the beetles), the regulated pressure of a small screw-press is necessary. After it has been well dried (which, of course, will take from a few hours to as many days, according to the size and nature of the object) it must be soaked in turpentine, or, what is better, distilled Canada balsam, until moderately transparent; if small, it must not be taken from the glass slide. A slip of glass of the recognized size, 3×1 inches, must be taken, a drop of balsam (the size of the drop proportionate to the size of the object) placed with the glass tube in the centre of the slide; the drop must then be made to spread slightly by the use of moderate heat, the object placed in it, and the thin glass cover applied with care. If any air-bubbles appear, they will generally be found to have dispersed after a day or two; and unless the object is valuable, it is best never to attempt to remount it. As the patience of the learner would be greatly tried during the process, it is always better to begin again with a fresh specimen. The balsam takes a long time to dry if left to itself, which is best; but if the objects are wanted early, they may be dried over a gas-jet, or by any other plan, so

that the heat be about 50° C.; this temperature will not do for all objects. The next thing is to finish the slide neatly. Paper covers are sold for this purpose; but the best plan for durability is simply to finish with a ring of Berlin black varnish; or even this may be omitted in some cases; the advantage of this plan is that the slides can be kept much cleaner &c. The white paper label can then be affixed with the English and scientific names, also what fluid &c. it is mounted in, and the date of the preparation. It can then be stored, if money is an object, in the cheap rack-boxes sold by Mr. Wheeler and other opticians at prices varying from sixpence upwards (these boxes are not covered with cloth); the boxes may then be numbered and placed on shelves in the same manner as books, whereby the objects are kept in a horizontal position.

Fluids had, until lately, greatly gone down in the estimation of microscopists as vehicles in which to mount various specimens; but glycerine and the more recent, if not so useful, substance silicate of potassa, which appears to be a very favourable semifluid for mounting certain structures, have again caused them to be used; and there are now varnishes and cements, such as the india-rubber and shellac cement, which, with care, will hermetically seal fluid preparations for many years. We will treat of the process. Take a slide, centre it on the turn-table, charge a camel's hair brush with the india-rubber cement, place the table in action and a ring or circular cell of the cement is formed, varying in depth according to the thickness of the fluid and the quantity used; turn a number of these cells and put aside to dry, to be used as wanted. With a pipette take from the alcoholic and camphor preservative fluid a sufficient quantity to fill the cell, soak the object in proof spirit for an hour or so to exhaust the air (it is better if the object has been kept in alcohol, see fig. 109); or it may be done in much less time under the air-pump; it is then placed in the centre of the cell, the thin glass cover placed gently over it, so as to exclude all air-bubbles; soak up all the surplus fluid with blotting-paper, centre the slide again on the turn-table, and seal the cell with a ring of

the liquid india-rubber cement; dry, and finish with Berlin black varnish, then label as usual. Whatever fluid is used, the process is nearly the same; but when glycerine or chloride of calcium is used the cell must be sealed either with Bell's cement or a saturated solution of gum-dammar in benzole; when the silicate of potassa is used it is hardly necessary to seal the cell at all, as the fluid dries at the edges and seals itself.

The next form of mounting is the dry system. A cell made of cardboard, gutta percha, ebonite, &c. is cemented to the centre of a glass slip, sufficient Berlin black is then used to cover the bottom of the cell, a small drop of pure gum or any good cement is placed in the centre; the object, which has also a minute quantity of the same cement on it, is then fixed exactly on the same spot, and the slide is left under a bell-glass to dry, after which a circle or square of thin glass is closely cemented to the top of the cell; the slide may then be finished with any black varnish, or it may be covered with any of the paper covers. If the specimen is to form a transparent object, the Berlin black must be left out of the cell; and it is best not to cement the object to the glass slide, as the cement often shows through and spoils the appearance; the object may be fixed by the slight pressure of a thin glass cover in a shallow cell.

In the mounting of objects, great care must be taken to show the structural characteristics of the specimen; for if this is attended to, a greater amount of valuable information will be obtained even from a "common object."

Algæ, Confervoid &c.—These show well when mounted in a preservative fluid consisting of 1 part alcohol to 7 water, mixed with an equal quantity of a cold saturated solution of camphor in distilled water. There are some seaweeds with their fructification that show best when mounted in balsam; but if glycerine or any other fluid which causes a strong exosmotic action on the cell-wall be used as the preservative fluid, it must be done by its gradual addition to the water in which the Algæ are contained, so that its action on the cell-wall and protoplasm will not be so abrupt as to cause

any rupture of the same. A solution of alum is also often used in the preservation of some of the Algæ: a fluid still better is the acetate of alumina, prepared by dissolving alum in acetic acid, crystallizing by evaporation, and to a saturated solution of this salt adding four or five parts of distilled water; or the acetate of alumina may be dissolved in the glycerine.

Bone, Teeth, &c.—Sections of these substances, if required to be mounted dry, are best made by cutting a thin section with the fine saw, and finishing by grinding down with a file until they are made as transparent as possible; they may then be mounted in a dry cell. The sections are best ground by fixing them to a slip of glass with strong balsam; the better methods of preparation are:—to cut a thin section after maceration in hydrochloric acid diluted with two parts water, then to mount in a cell with a fluid composed of acetic acid 1 part, water 2 parts; or the broken bone, tooth, &c. may be placed in a fluid of 1 part glycerine, 1 part water, for a few hours, then add gradually a mixture of glycerine and acetic acid equal parts; after a short time thin sections may be cut with a fine scalpel. Mount in a preservative fluid, acetic acid 1 part, water 3 parts; or it may be mounted in glycerine, or glycerine and acetic acid equal parts.

Crystals.—The formation of crystals, from saline and other solutions, under the microscope yields an extremely interesting and useful study,—for example, the beautiful appearance of the crystals of chloride of ammonium caused by holding for a few seconds a glass slide that has had one drop of hydrochloric acid spread over the surface, over the fumes or vapour of ammonia: upon the gradual evaporating of this thin film of fluid, fine feathery crystals are formed; they are produced by the ammonia combining with the hydrochloric acid. These crystals may often be developed from the human breath, more especially in certain forms of disease.

Some forms of crystals are best produced by placing a drop of the solution under a thin glass cover and letting the fluid evaporate gradually. The majority of crystals formed from the various salts &c. are best mounted in castor-oil and sealed

with the gum-dammar cement; many show well when mounted in a solution of balsam in chloroform.

Desmidieæ &c.—For the mounting of these lower forms of vegetable life, see Algæ; they are best collected by taking the green scum from the margins of ponds situated in open and exposed districts, and placing this green matter in a white saucer nearly full of water: shade, all but an inch or so, from the surrounding daylight; and in the space of a few hours, if fresh, the Desmids will be found massed at the place that has been left exposed to the light; with a pipette they may then be separated from the surrounding substances, and mounted in a shallow cell with one of the preservative fluids. They are found in the greatest quantity in the later summer and the autumn months.

Diatoms are collected in nearly the same manner as Desmids, from which they may be distinguished by their light brown colour; they are often found growing in tufts upon the marine and the freshwater Algæ. Their mode of preparation is rather difficult; but, in a few words, the following will be found the best process:—Burn the deposit in a platinum spoon until it assumes the appearance of a white ash, then boil in nitric acid for a short time, when most of the siliceous valves will be found quite clean: the large glass tubes used by chemists for collecting hydrogen and other gases will be found, on account of their length, of great assistance in separating the species according to their specific gravities; they may then be mounted dry, in balsam, or in some fluids, but not silicate of potassa.

The name of the species of Diatom, if known, must be immediately written on the slide. This rule holds good with all specimens, as, if a note is not made at the time, it is liable to be forgotten.

Entozoa.—Many of this class of animals exhibit their anatomy best when mounted in glycerine; they also mount well, after preparation, in balsam. If surrounded by germinal matter, the use of the carmine or other dye to be used as a stain will cause the parasite to appear better, the dye staining the surrounding mass and leaving the animal untouched: an

example of this class is seen at fig. 115. An interesting species for observation will be found in the *Anguillula glutinis,* found in sour paste.

Ferns and Mosses.—The investigations into the structure of the minute reproductive organs of these plants form an interesting branch of microscopy. Mosses (more especially at the time of the year when nature partially hides her glory) may be taken up as a special object of study; for their structural peculiarities are developed chiefly in winter. Many of the smaller species may be mounted entire, after soaking for a short time in water and draining off the same: they show well when mounted in the silicate of potassa; but most of the minute characters show best in balsam. The parts of the fronds of various species of Ferns which exhibit the sori show best when mounted dry.

Lichens, when entire, are mounted dry; but, to show the apothecia &c. well, the sections of the thallus must be mounted in glycerine or balsam.

Fungi.—Sections of spores &c. are generally best when mounted in the preservative fluids, as recommended for the Algæ; but many of the micro-Fungi may be mounted *in situ* in a dry opaque cell; and some of the brands &c. show best when mounted in balsam.

Leaves and Petals.—The cuticles of these parts of plants form a large range for investigations. Most cuticles are prepared by boiling the leaf in a fluid made by adding about four parts of water to one of nitric acid; but the proportion must vary according to the nature and strength of the leaf. After the cuticle is separated by boiling in this fluid, it must be floated off from the waste tissue, delicately washed with a fine camel's-hair pencil, and mounted in a suitable fluid according to its thickness &c.,—if thick, in glycerine or balsam; if thin, in any of the fluids recommended for the Algæ &c. The cuticles of the petals are best when torn from the surface; but for petals I prefer the colouring-matter to be nearly obliterated by the use of ether; then add weak sulphuric acid, dry, and mount in balsam; or some show best when mounted dry.

Most of the other vegetable tissues, such as spiral-vascular, scalariform, &c., are best mounted in glycerine &c.

Spicula &c.—See figs. 107 and 108.

Starches.—Many of these may be mounted in silicate of potassa, care being taken to moisten the starch first, or air-bubbles will be formed, which are difficult to get rid of in this substance without the use of the air-pump; if required for the polariscope, balsam is best. For other remarks, see the starches (figs. 53, 54, &c.).

Insects, parts of, &c., are best when mounted in balsam, although some of the smaller ones perhaps exhibit their structure better when mounted in acetic acid, 1 part acid to 2 parts water; they may be mounted in one of Pumphrey's ebonite cells, or in a cell made of the india-rubber cement; in both cases this is the substance with which to seal the cell. For other information on mounting &c., see Insects.

Palates, or tongues of the Gasteropoda, a class belonging to the Mollusks, are generally dissected from the animal, cleaned with potass, washed, dried, and mounted in balsam; they are then generally seen under the polariscope. Some, like the whelk's tongue, require to be slit up the centre, spread out and dried; they show well when mounted in glycerine.

Zoophytes, Rotatoria, &c. show best when mounted in a fluid as nearly as possible like their native element.

White slabs to be used for dissections &c. are made of the white gutta-percha enamel (sold as a tooth-stopping) mixed with white wax; after this substance is run out into slabs about the $\frac{1}{16}$ of an inch in thickness, they may be cut up and used at the bottom of the cells when it is required to exhibit any particular dissection in its natural position; for rough purposes ordinary gutta percha may be used, mixed with wax in the same manner. For dissections under water the gutta-percha and wax substance must be melted at the bottom of a deep white vessel; the porcelain dishes that photographers use will do for this purpose; a common dish, if deep, may be used.

In staining tissues the germinal or growing matter is coloured, and the formed or mature matter is not. But, then, do not use Judson's dyes; they dye every thing: see *Demodex* (fig. 173), Entozoa, &c.

The addition of weak hydrochloric or nitric acid is useful for breaking up cellular tissue &c.

Thin sections of most substances can be well cut by soaking them in the india-rubber cement, which must be allowed to dry; the sections may then be made with a razor or scalpel.

For the observation of any object the student must place the same between a glass slip and a piece of thin glass. Water is the fluid most generally used for rough observation; but this must be left to observation and experiment. And in the mounting of objects common sense must be used; for instance, an opaque-looking object is generally best mounted in balsam, as it has good refractive powers, and a transparent substance is generally best seen when mounted either dry or in fluids.

Dust must be carefully kept from all preparations whilst in progress.

The author must now conclude, trusting that his readers will find these rough notes useful, and that the study of some of the hidden forms made by Divine art will lead him to search further for the marvellous beauties of nature.

ERRATA.

Page 10, fig. 20, line 8, *for* circulation *read* nutrition.

Page 54, fig. 108, line 7, *for* diluted potassa fusa, *read* in a diluted solution of potassa fusa.

Page 63, fig. 126, line 7, *for* therefore &c., *read* therefore each of the facets receives an image of the object before them.

Page 64, fig. 128, line 9, *for* the rasp-like bodies in &c., *read* the rasp-like bodies of the male insect in the &c.

Page 86, fig. 171, *for* Order Acarind *read* Order Acarina.

INDEX.

THE END.

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